BEFORE THE NATIONAL GREEN TRIBUNAL, NEW DELHI

In

Original Application 1156/2024

IN THE MATTER OF:-

"Glacial Lakes multiply in Himachal Pradesh and Tibet, posing a threat to lives and infrastructure downstream" appearing in The Hindu dated 11-08-2024.

COUNTER AFFIDAVIT/REPLY ON BEHALF OF RESPONDENT NO. 3 & 4.

PAPER BOOK

(KINDLY SEE INDEX INSIDE)

ADVOCATE FOR RESPONDENT NO. 3 & 4.

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PLACE:SHIMLA
DATE: 02.01.2025

Advocate for Respondent no 3 & 4.

sanya kaushal

SANYA KAUSHAL
ADVOCATE
D/7794/2017

BEFORE THE NATIONAL GREEN TRIBUNAL, NEW DELHI

In

Original Application No. 1156/2024

IN THE MATTER OF:-

"Glacial Lakes multiply in Himachal Pradesh and Tibet, posing a threat to lives and infrastructure downstream" appearing in The Hindu dated 11-08-2024.

...Applicant

Versus

1. G.B.Pant Institute of Himalayan Environment, through its Director, Kosi-Katarmal,Almora-263 643 Uttarakhand, India.
2. Ministry of Environment, Forest &Climate Change through its Secretary, Indira Paryavaran Bhawan Jorbagh Road,New Delhi-110003.
3. Department of Environment Science Technology & Climate Change through its Chief Secretary, Paryavaran Bhawan, Near U.S Club, Shimla Himachal Pradesh-171001
4. Himachal Pradesh Council For Science Technology & Environment (HIMCOSTE) through its Chairperson, Environment, 34 SDA Complex, Kasumpti, Shimla-171009.

..........Respondents

COUNTER AFFIDAVIT/REPLY ON BEHALF OF RESPONDENT NO. 3 & 4.

Director, Department of Environment, Science Technology & Climate Change, Shimla, H.P

ATTESTED

OATH COMMISSIONER

MOST HUMBLY SHEWETH:

1. I, D.C. Rana S/o Sh. S.R Rana aged about 53 years, presently posted as Director, Department of Environment Science Technology &Climate Change (DEST&CC) cum Member Secretary, Himachal Pradesh Council For Science Technology & Environment (HIMCOSTE) to the Government of Himachal Pradesh at Shimla, do hereby solemnly affirm and declare on oath that the accompanying reply has been prepared and drafted at the instance of Respondent No.3 & 4 as per record.

2. That the deponent is an official working under the State of Himachal Pradesh and is well versed with the facts of the case and accordingly competent and duly authorized to swear upon the instant counter affidavit/reply.

3. That present reply is submitted by the State of Himachal Pradesh in response to the directions issued by the Hon'ble National Green Tribunal (NGT) in Original Application No. Original Application No. 1156/2024 titled as "News Item titled ***"Glacial lakes multiply in Himachal Pradesh and Tibet, posing a threat to lives and infrastructure downstream" appearing in The Hindu dated 11.08.2024"*** dated 12.09.2024.

Director, Department of Environment, Science Technology & Climate Change, Shimla, H.P

4. That the answering respondents respectfully submit this reply to address the issues highlighted in the present Original Application concerning the increasing number of glacial lakes in Himachal Pradesh and Tibet and their potential risks to lives and infrastructure downstream. The Respondents acknowledge the seriousness of the issue and reiterate their commitment to environmental conservation and disaster risk management in line with sustainable development goals.

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5. That the answering Respondents submit that they are actively working under the ambit of the Environment Protection Act, 1986, and other relevant legislative frameworks to mitigate risks associated with glacial lakes, climate change, and associated environmental hazards. Respondents are continuously involved in implementing proactive measures for monitoring glacial lakes, formulating disaster management strategies, and promoting sustainable environmental practices in Himachal Pradesh. As the warming of Earth is a global phenomenon impacting diverse regions, from the Himalayas to coastal areas and has been a major issue of concern not only for Himalayan States but also all across the globe affecting the Arctic & Antarctic ice reserves. Global warming is a significant contributory factor to the formation of glacial lakes in the higher Himalayan regions, driven by the ongoing melting of glaciers. While the state of Himachal Pradesh has initiated various measures to address the local consequences, such efforts, in isolation, are often insufficient in combating the broader global crisis. International frameworks, including climate change conventions, are pivotal in establishing binding commitments for participating states to reduce Greenhouse Gas (GHG) emissions, the principal driver of global warming. Himachal Pradesh is proactively engaged in mitigating these localized impacts through state-level interventions. Nevertheless, a comprehensive, coordinated global response is imperative to secure meaningful and sustainable solutions to this transnational environmental challenge.

Director, Department of Environment, Science Technology & Climate Change, Shimla, H.P

6. That the study titled "Monitoring of Glacial Lakes/Water Bodies in the Satluj Catchment using RS & GIS Techniques for the Year 2023" has been conducted by Himachal Pradesh Council for Science, Technology & Environment (HIMCOSTE) on behalf of Satluj Jal Vidyut Nigam Limited (SJVNL). Himachal Pradesh, a modest and mountainous state

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in the Western Himalayan region, serves as the source of transit for many of North India's major rivers, including the Chenab, Beas, Ravi, and Satluj, along with their perennial tributaries, which originate from or pass through the state's glaciated Higher Himalayas. The glaciological studies have been undertaken by HIMCOSTE utilizing satellite data from various sensors and resolutions.

7. That answering respondents humbly submits that the formation of glacial lakes has been monitored using Indian Remote Sensing (IRS) satellites, including ResourceSat, RS-2, RS-2A, the Advanced Wide Field Sensor (AWIFS), the Linear Imaging and Self Scanning Sensors (LISS), LISS-III, and LISS-IV satellite data. The spatial resolutions of these sensors are 56 meters (AWIFS), 23.5 meters (LISS-III), and 5.8 meters (LISS-IV). To develop a comprehensive inventory for lake monitoring, the studies are primarily conducted during the ablation season, which occurs from April to November. Over a four-year period, from 2020 to 2023, data from these three high-resolution sensors (LISS-III, LISS-IV, and AWIFS) have been utilized and compiled into the report.

Director, Department of Environment, Science Technology & Climate Change, Shimla, H.P

8. That it is respectfully submitted that the Mansarover Lake, located in the Tibetan Plateau and serving as the source of the Satluj River, along with the upper catchment area of the SJVNL power plant upstream of Jhakri, is regularly monitored by the State Centre on Climate Change of HIMCOSTE. This monitoring encompasses all glacial lakes and water bodies within the Satluj watershed. As per the data from HIMCOSTE, the number of glacial lakes in the region has significantly increased, rising from 562 in 2019 to 1,048 in 2023. The study is conducted annually across various basins of the Satluj catchment,

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including the Spiti Basin, Lower Satluj Basin, and Upper Satluj Basin. The detailed report is marked and annexed here as **Annexure-1.**

9. That it is further submitted that the analysis for 2023 indicates that the Upper Satluj Basin accounts for the highest proportion of newly formed lakes, approximately 65%, followed by the Spiti Basin at approximately 18%, and the Lower Satluj Basin at approximately 17%. The study also reveals that the Upper Satluj Basin, due to permafrost conditions leading to the formation of high-altitude wetlands in the adjacent Trans-Himalayan region, is more susceptible to climate-induced changes. These vulnerabilities are likely to result in the formation of a significantly larger number of such lakes in the Upper Satluj Basin compared to the Lower Satluj and Spiti Basins.

10. That it is an established fact that the melting of snow and glaciers serves as a direct indicator of climate change, with rising temperatures having a pronounced adverse impact. This leads to the melting of permafrost and glaciers and causes snow-covered regions to experience significant seasonal variations. The observed increase in the number of small lakes further signifies the detrimental effects of global temperature rise, with Himalayan glaciers in higher-altitude regions being more severely affected than those in lower-altitude areas.

Director, Department of Environment, Science Technology & Climate Change, Shimla, H.P

11. That in the light of the prevailing trends in climatic variations and the increasing risks associated with climate-induced hazards, particularly glacial hazards, it is submitted that satellite remote sensing data possesses significant technical potential and has demonstrated efficacy in monitoring and analyzing such developments in the higher Himalayan regions. The answering respondents acknowledge the need of regular and systematic monitoring of glacial lakes through advanced satellite-based techniques which is imperative for assessing the

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vulnerability of these regions and for devising effective mitigation strategies to address and minimize the risks arising from such climate-induced phenomena.

12. That it is humbly submitted, in view of the prevailing trends in climatic variation and the escalating threat of climate-induced hazards, particularly those associated with glacial activity, satellite-based remote sensing technologies possess substantial potential and have proven to be highly effective in monitoring and analyzing developments in the higher Himalayan regions. It is respectfully submitted that regular and systematic monitoring of glacial lakes in these areas is crucial for accurately assessing vulnerabilities and implementing targeted mitigation measures to address and minimize the risks arising from such hazards.

13. That it is humbly submitted before the Hon'ble Tribunal that the Government of Himachal Pradesh has adopted a vigilant approach and implemented several mitigation measures to minimize the risk associated with the potential outburst of glacial lakes. In furtherance of its commitment to environmental protection and the conservation of glaciers located within the State, the Government has undertaken various indirect measures aimed at ensuring sustainable management and preservation of these vital natural resources.

Director,
Department of Environment, Science Technology &
Climate Change, Shimla, H.P

14. It is further submitted that the State Disaster Management Authority, operating under the aegis of the Department of Revenue, in collaboration with the National Disaster Management Authority (NDMA), is actively monitoring the four most vulnerable pro-glacial lakes in Himachal Pradesh. The details of these vulnerable lakes are as follows:

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1.	Gepang Gath Chenab: 92.009 Ha, Lahaul & Spiti, Elevation :- 4098 mts **Field Survey: completed from 26th to 30th July, 2024)**
2.	Parvati (Upstream of Khir Ganga left bank): 12.490 Ha, Kullu, Elevation: 4502 mts **(Field Survey: completed from 08th to 15th October, 2024)**
3.	Baspa (Upstream of Sangla left bank) 18.886 Ha, Kinnaur, Elevation 4714 mts **(Field Survey: completed from 06th September, 2024)**
4.	Satluj (NW of Kalka along Kashang Gad on its right bank : 27.8999 Ha, Kinnaur, Elevation 4275 mts **(Advance Reconnaissance and efforts done but field surveys by experts shall be made to complete during this year depending on weather conditions since the area remains inaccessible most of the time.**

It is respectfully submitted that the Disaster Management Cell has prepared and submitted a preliminary project proposal to the National Disaster Management Authority (NDMA) for the mitigation of risks associated with the aforementioned four pro-glacial lakes. For detailed studies, the Disaster Management Cell is collaborating with the Centre for Development of Advanced Computing (C-DAC), Pune, and the National Remote Sensing Centre (NRSC), Hyderabad. The geological and bathymetric surveys of two lakes, namely Parvati

Director, Department of Environment, Science Technology & Climate Change, Shimla, H.P.

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(upstream of Khir Ganga) and Baspa (upstream of Sangla), have been successfully completed by C-DAC, Pune. Furthermore, NRSC, Hyderabad, has finalized the modeling for Gephang Gath Lake. Additionally, an on-site survey of the Satluj Lake (northwest of Kalpa along the Kashang Gad) is scheduled to be conducted post-winter season. The commencement of mitigation work on these lakes is contingent upon the receipt of funds from the NDMA.

It is further submitted that, with regard to environmental protection and the conservation of glaciers within the State, the Government of Himachal Pradesh has undertaken several indirect measures, as detailed below:

Some of the prominent measures undertaken by the State are as follows:

1. **State-Specific Action Plan on Climate Change**
2. **Institutional Framework** to address various facets of climate change (2012 & 2021)
3. **Strategy and Action Plan** for generating awareness and education (IEC)
4. **Adaptation Measures** to combat the impacts of climate change across different sectors
5. **National and International Initiatives** to mitigate the effects of climate change on the livelihoods of people
6. Preparation and assessment of the **Greenhouse Gas (GHGs) Emissions Inventory** for the State in 2009 and 2012
7. **Reduction of GHG Emissions** by banning fossil fuels and other traditional materials for space heating
8. **Climate Change Adaptation-Focused Sustainable Water Resources Strategy** for Himachal Pradesh carried out by the Asian Development Bank

Director, Department of Environment, Science Technology & Climate Change, Shimla, H.P

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9. Collaboration with **Mandals and Local Rural Communities** for resource collection
10. **Introduction of Alternate Battery-Operated Public Transport Systems** in major hill destinations across the State

According to the India State of Forest Report (ISFR) 2023, the forest cover of Himachal Pradesh has been recorded as 15,580.35 square kilometers, accounting for 27.99% of the state's geographical area. This reflects an increase of 54.73 square kilometers in forest cover compared to the year 2021. The State has set a target to increase its forest cover to 30% of the geographical area by the year 2030. This objective aligns with the State Government's commitment to enhancing green cover and creating additional carbon sinks through forestry interventions. Consequently, Himachal Pradesh is making a significant contribution at the national level to the Nationally Determined Contributions (NDCs) under the Paris Climate Change Agreement. Although the Government has consistently been proactive in safeguarding its environment, several initiatives, as outlined above, are being implemented for its protection and conservation. Regarding the effectiveness of these initiatives in assessing their impact on the Himalayan glaciers, various studies are being conducted by different institutions to examine the effects of black carbon deposition on the glaciers. However, these studies remain in the monitoring phase.

Director,
Department of Environment, Science Technology &
Climate Change, Shimla, H.P

15. That the present reply may kindly be taken on record.The answering Respondent further craves the leave of this Hon'ble Tribunal to place additional documents on record, if required, and make detailed submissions at the time of hearing.

ATTESTED

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DEPONENT

Director,
Department of Environment, Science Technology &
Climate Change, Shimla, H.P

VERIFICATION:

I, the above-named deponent, do hereby verify that I have read and understood the contents of the above counter affidavit/reply, and that the same are true and correct to the best of my knowledge and belief. No part of the same is false, and nothing material has been concealed therefrom. Verified at Shimla on this 2nd day of Jan 2025

Sujata
Identified by

ATTESTED
OATH COMMISSIONER

DEPONENT

Director,
Department of Environment, Science Technology &
Climate Change, Shimla, H.P

Certified that the above/overleaf was declared before me on solemn affirmation on this 2nd day of Jan 25 at Shimla in the District of Shimla by Sh. D.C. Rana who was identified by Dr. Sujata L.O. who is personally known to me and the contents of the ... have been read over & explained ... in vernacular who admitted them to be correct and true at the time of making there of

2-1-25
Oath Commissioner
HP High Court, Shimla

All Cuttings, Corrections & Additions are attested by me
2-1-25
Oath Commissioner

H.P. COUNCIL FOR SCIENCE, TECHNOLOGY & ENVIRONMENT (HIMCOSTE)
B-34, SDA-Complex, Kasumpti, Shimla-9
Tel Number: 0177-2621992, FAX: 0177-2620998
www.himcoste.hp.gov.in

No. SCSTE /CCC/F (7)-6/2010/Consultancy-Vol-VIII - 926. **Dated:** -01/05/24

From: - **The Member Secretary,**
HIMCOSTE, Vigyan Bhawan,
Bemloe, Shimla-171001 H.P.

To **The Deputy General Manager (Dam- O&M),**
NJHPS, Satluj Jal Vidyut Nigam Ltd. (SJVNL) Nathpa,
Tehsil Nichar, District Kinnaur-172115 H.P.

Subject: **Final technical report on the study "Monitoring of Glacial Lakes and Water Bodies in Satluj Catchment (PCD-2747)"**

Sir,

Kindly refer to your letter No. SJVNL(NJHPS)/P&C/PCD-2831/1135-40 dated 20-07-2023 vide which the study entitled "**Monitoring of Glacial Lakes and Water Bodies in Satluj Catchment for the year 2023**" using space data at a total cost of **Rs. 12, 22, 450/-** (Rs. Twelve Lakh Twenty-Two Thousand Four Hundred Fifty only) + GST Extra @ 18% as per the terms and conditions mentioned in the work order was entrusted to State Centre on Climate Change of the HIMCOSTE for carrying the study as per past.

In this regard, based on the analysis carried out using AWiFS, LISS III and LISS IV satellite data for the year 2023, the findings have been compiled in the form of a technical report and the copy of the same is being forwarded for further action at your end please.

It is also requested that the request for carrying the study during 2024 may also be conveyed to us, so that the proposal and financial estimates could be worked out timely as the ablation season has already been started w.e.f. April onwards.

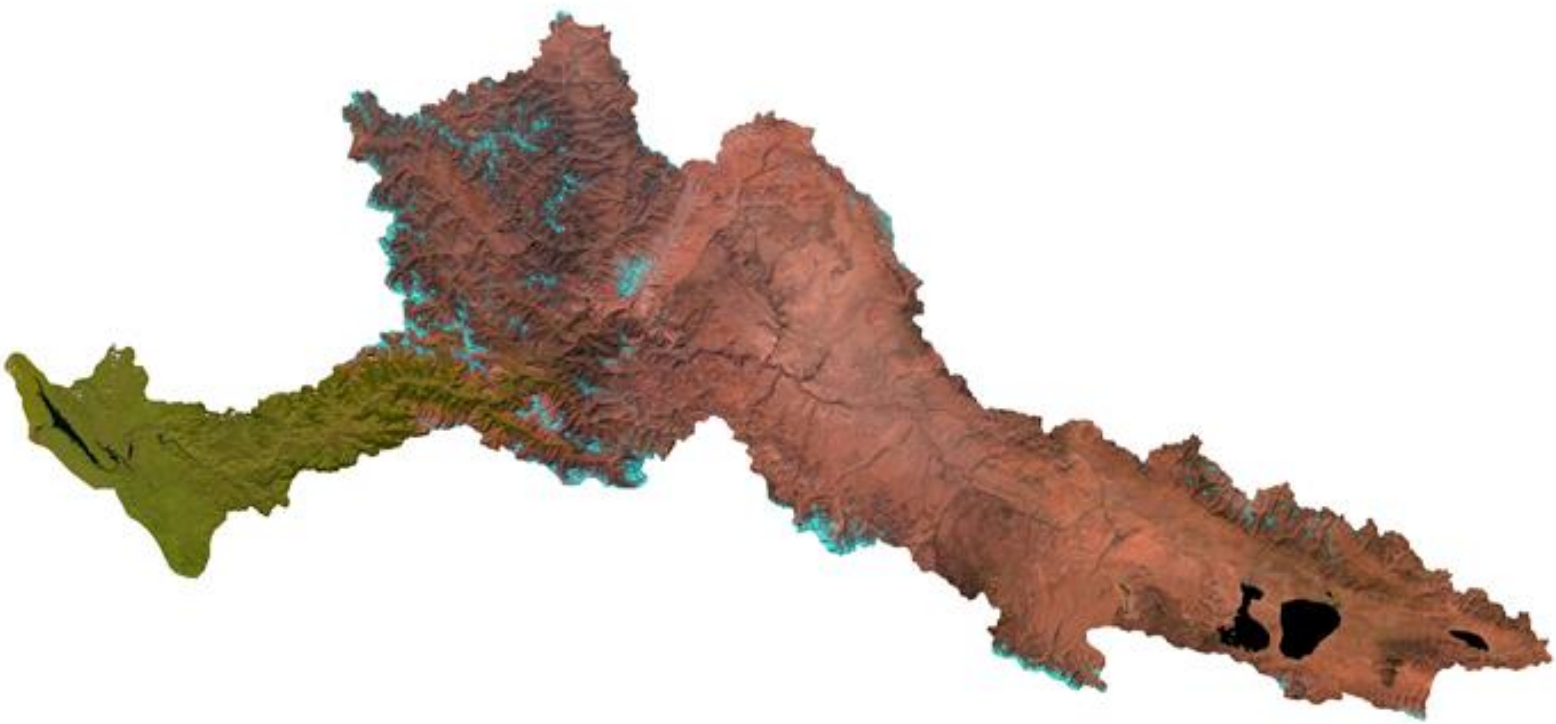
Thanking you.

Yours sincerely,

(signed) 2/5/24

(Dr. Suresh C. Attri)
Joint Member Secretary

MONITORING OF GLACIAL LAKES/WATER BODIES IN SATLUJ CATCHMENT USING REMOTE SENSING& GIS TECHNIQUES DURING THE YEAR 2023



Submitted to

Satluj Jal Vidyut Nigam Ltd. (SJVNL)

DAM (O & M) NJHPS, Nathpa, Kinnaur, Himachal Pradesh

Prepared by

State Centre on Climate Change

H.P. Council for Science, Technology & Environment

B-34, SDA Complex, Kasumpti, Shimla-9 H.P.

DOCUMENT CONTROL AND DATA SHEET

Report Number	SCSTE/HPSCCC/Const/SJVNL/2023
Month & Year of Publication	April, 2024
Title	Monitoring of Glacial lakes/water bodies in the Satluj catchment using RS & GIS Techniques
Type of Report	Scientific Report
Authors	S.S. Randhawa, Neha Thakur, Monika Chauhan
Originating Unit	State Centre on Climate Change (H.P. Council for Science, Technology & Environment, HIMCOSTE), B-34, SDA-Complex, Kasumpti, Shimla-9 H.P.
Abstract	The recent trends of climatic variations over the Himalayan region led to undergo various changes in the cryosphere regimes. Various in-situ as well as space-based studies reveals that spatial extent of majority of glaciers is changing very fast leading to the formation of moraine dammed lakes or the supra glacier lakes over the Himalayan regions. Susceptibility of the State of Himachal Pradesh to vagaries of these climatic variations is now been well documented and appreciated. Scientific insight gained from the analysis of multi spectral satellite images carried out by various authors suggests that there has been a considerable increase in the number of such lakes in each basin in the State of Himachal Pradesh, posing potential threat to the infrastructure and human life thriving in the downstream areas of many drainage systems originating from the snow clad mountains ranges in the State and can be disastrous in the event of any break due to one or the other reasons. As per one of the studies carried out in Himachal Himalaya, the number of such lakes has been found to be on the increasing side in the present era of climatic variations. The present study has been carried out using AWiFS, LISS III and LISS IV satellite data for the year 2023 in the Satluj catchment of SJVNL Hydro Electric Project. The interpretation was carried out using ERDAS Imagine 9.3 software. The results obtained for the year 2023 have been compared with that of 2022 to assess the temporal changes in the water spread of the lakes. Regular monitoring of Parechhu Lake was also been done separately using LISS IV and LISS III data from April to September during 2023. Based on the AWiFS satellite data for 2023, 466 lakes could be delineated comprising 67 from Spiti, 58 from Lower Satluj and 341 from Upper Satluj basin. Likewise, from LISS III data total number of lakes /wetlands a total of 1048 lakes mapped and the number varies from 562 (2019) to 993 (2020) to 880 (2021) to 995 (2022) to 1048 (2023) in the Satluj catchment during 2023. Using LISS IV satellite data, a total of 2292 lakes were delineated in comparison to 1953 lakes/high altitude wetlands of 2022 comprising 470 (20%) from Spiti basin, 487 (21%) from the Lower Satluj basin and 1335 (58%) from the Upper Satluj basin i.e., basin 3, out of which 449 lakes have been classified as high-altitude wetlands and the remaining 1743 as from the glacial origin. Water bodies have also been observed along the river course which can be potentially vulnerable and needs regular monitoring by virtue of their size, location and nature. In view of the recent events in Sikkim and Uttrakhand Himalaya, a proper monitoring of all such lakes is very much essential in the Himalayan region in view of the recent NDMA Guidelines for the Management of GLOFs and LLOFs in order to avoid any eventuality like in Uttrakhand in future, which will not only save the precious human life but also the public and government property.
Security classification	Unrestricted

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ACKNOWLEDGEMENT

The H.P. Council for Science, Technology & Environment, Government of Himachal Pradesh acknowledges Satluj Jal Vidyut Nigam Ltd. for entrusting the study for monitoring of all glacial lakes/water bodies in the Satluj Catchment as part of their disaster preparedness program in their projects. The authors are also thankful to the Member Secretary (EC) and the Joint Member Secretary, Himachal Pradesh Council for Science, Technology & Environment (HIMCOSTE) for constant support and allowing us to undertake the investigation as part of the disaster management activities in the State Centre on Climate Change of the Himachal Pradesh Council for Science, Technology & Environment (HIMCOSTE) using space technology.

LAKES/WATER BODIES IN SATLUJ CATCHMENT USING RS, GIS & IMAGE INTERPRETATION TECHNIQUES

TEAM MEMBERS

Dr. S.S.Randhawa

Principal Scientific Officer

Neha Thakur

Scientific Professional

Monika Chauhan

Scientific Professional

State Centre on Climate Change

H.P. Council for Science Technology & Environment,

B-34 SDA Complex, Kasumpti, Shimla-9 H.P.

1. BACKGROUND

Mountain ecosystems harbour a wide range of significant natural resources and play critical role in the ecological and economic processes of the Earth. Deforestation, landslides, land degradation, desertification and Glacier Lake Outbursts Flooding (GLOFs) are some of the common environmental issues in the mountain regions. The major challenge currently faced by the mountain environment is the escalation of these issues through atmospheric as well as man-induced changes.

Mountain systems are particularly sensitive to climate changes. Since industrialization, human activities have resulted in steadily increasing concentrations of greenhouse gases-particularly carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbons (CFCs) and nitrous oxide (NOx) in the atmosphere. As these gases absorb some of the radiation emitted by the Earth rather than allowing it to pass through the atmosphere to space, there is general consensus that the Earth's atmosphere is warming. The third assessment report of the Inter–Governmental Panel on Climate Change (IPCC, 2001) concludes that global average surface temperatures have increased by 0.6 ± 0.2°C during the 20th century and that, for the range of scenarios developed, the global average surface air temperature is projected to warm 1.4 to 5.8°C by 2100 relative to 1990. Through the recent release of 21-page report in Paris the Intergovernmental Panel on Climate Change (IPCC) observed that "Warming of the Climate System is unequivocal as is now evident from observation of increase in global air and ocean temperatures, widespread melting of snow and ice and rising global mean sea land" Analysis of the temperature trend in the Himalayas and its vicinity shows that temperature increases are greater in the uplands than lowlands areas. Regional changes in climate have already affected diverse physical and biological systems in many parts of the mountain regions. Shrinkage of glaciers, thawing of permafrost, late freezing and earlier break up of ice on rivers and lakes, pole ward and altitudinal shifts of plant and animal species, declines of some plant and animal population, and earlier emergence of insects have been observed (IPCC, 2001). Climate influences weathering processes, erosion, sediment transport, and hydrological conditions. It also has an impact on biodiversity by influencing the kind, amount, stability, and quality of vegetative cover. Mountain systems are particularly sensitive to climate changes. Small changes in climate can produce significant regional or larger-scale effects. In particular, marginal environments are under high stress. Small changes in water availability, floods, droughts, landslides and late frosts can have drastic effects on agriculture economics.

Geological history of the Earth indicates that glacial dimensions are constantly changing with changing climate. There have been at least 17 major glacial advances (glaciations) in the last 1.6 million years alone. The most recent, the Last Glacial, reached its peak some 20,000 to 18,000 years ago and came to an end about 10,000 years ago (Goudie, 1983). Glaciations are followed by "interglacial" periods, during which the glacier ice retreats as a result of global warming. The interglacial typically continues for about 10,000 years before the cooling or the next glacial begins. This cyclical activity is generally accepted to be caused by gradual changes in the earth's rotation, tilt and orbit around the sun, which affects the solar radiation the earth receives. This suggests that glaciers are constantly changing with time and these changes can profoundly affect the run off the Himalayan Rivers. In the Himalayas there are about 33,000 sq. km. area is covered by glaciers and this is one of the largest concentrations of glaciers outside the Polar Regions. Melt water from these glaciers forms an important source of runoff into the North Indian Rivers during the peak months.

Glacial cycles are punctuated by relatively short periods of localized cooling and warming, during which glaciers advance and retreat. The most recent cooling episode of the present interglacial commonly referred to as the "Little Ice Age" (LIA), affected parts of North America (Curry, 1969), Asia (Chu ko-Chan,1973) and Europe from about 1300 AD through to the latter half of the 19th century. During the LIA (1550-1850 AD) glaciers were much longer than today (Yamada et. al., 1998). It may have been the result of volcanic eruptions and the presence of volcanic ash in the atmosphere that caused cooling by reducing the amount of solar radiations reaching the earth's surface (Lamb, 1970). Changes to ocean currents have also been suggested, as has the tectonic activity, concentration of carbon dioxide in the atmosphere, and sunspot activity (Goudie, 1983).

2. PRESENT SCENARIO

Himalayan glaciers have also been found to be in a state of general retreat since 1850 (Mayewski & Jeschke, 1979). The Khumbu glacier, a popular climbing route to the summit of Mt. Everest, has retreated over 5 km from where Sir Edmund Hillary and Tenzing Norgay set out to conquer the world's highest mountain in 1953. Since the mid1970s the average air temperature measured at 49 stations of the Himalayan region rose by 1°C with high elevation sites warming the most (Hasnain, 2000). This is twice as fast as the 0.6°C average warming for the mid –latitudinal northern hemisphere over the same time period (IPCC 2001b), and illustrates the high sensitivity of mountain regions to climate change. The Dokriani Bamak glacier in Uttranachal Himalayas has retreated 20 m in 1998, and the Gangotri glacier is reducing at a rate of 30 m/year.

At present the rivers have shown 3-4% surplus water due to a 10% increase in the melting of the glaciers of the western Himalayas, and a 30% increase in the Eastern Himalayan glaciers. But, after 40 years, most of these glaciers will be wiped out and then South Asia will have water problems. In March 2002, UK's Department of International Development funded a project called Sagarmatha (Snow and Glacier Aspects of Water Resources Management in the Himalayas) to assess the impact of deglaciation on the seasonal and long-term water resources in snow-fed Himalayan rivers. This study was vital for policy-makers and especially those working on interlinking of rivers, as the flows available in rivers are likely to change dramatically over the decades depending on the region. The study which reveals some major facts about the melting mountain majesties and warming glaciers is an eye-opener.

In Upper Indus, the study sites show initial increases of 14% and 90% in mean flows over the next few decades which will be followed by decreasing flows by 30% and 90% of baseline in the subsequent decades in a 100-year scenario. For Ganges, the response of the river near the glacier in Uttarkashi is different from downstream Allahabad. At Uttarkashi, flows peak at between 20% and 33% baseline within the first few decades and then recede to 50% of baseline after 50 years.

Near the source of the Brahmaputra, there is a general decrease in decadal mean flows for all temperature scenarios as glaciers are few in the area and flows recede as the permanent snow cover reduces with increasing temperature. The catchments in the eastern Himalayas which benefit from high precipitation of the summer monsoon, are more vulnerable to impacts of deglaciation than those in the west where the monsoon is weaker.

In short, the deglaciation in the Himalayas is influenced by various factors, climatic, regional etc. However, the main underlying factor is ever increasing warming on the mountains, chiefly because of excess emission of greenhouse gases and Asian brown cloud. The ongoing ice melting is only the tip of the iceberg that will hit us in the near future.

As the Indian economy depends to a great extent on agriculture- a highly climate sensitive sector and the knowledge about potential climate change impacts on agriculture has special significance. Agriculture productivity is sensitive to two broad classes (a) direct effects from change in temperature and (b) indirect effects through changes in soils, distribution and frequency of infestation by pests, insects, diseases or weeds etc. Several studies predict that rice and wheat yield would decline considerably with climatic changes in India. As the mountain areas accounts only 21% of the total geographical area of India, where about 60-70% population largely depends on agriculture, horticulture and animal husbandry related activities for their livelihood. If the present trend of climate change continues, this will have adverse effect on their lifestyles.

Since the climate is an important determinant of geographical distribution, composition and productivity of forest, at the simplest level, changing pattern of climate will change the natural distribution limits for species or communities. In the absence of barriers, it may be possible for species or communities to migrate in response to changing conditions. Vegetation zone move towards higher latitude following shifts in average temperature. These changes in turn, could have profound implications for traditional livelihood, industry, biodiversity, soil and water resources and hence agriculture productivity. More over these climate change induced effects would aggravate the existing stress due to non-climate factors, such as land use changes and unsustainable exploitation of natural resources. Some of the climate induced changes observed in the context of the mountain environment in Himachal Pradesh are as follows.

- Declining snow fall.
- Drying up of perennial streams.
- Temperate belt has shifted upward.
- Productivity of apple has been adversely affected.
- Rabi seasons has been shifted and shortened.
- The incidences of diseases and pests have become more severe.

2.1 GLACIATION IN THE INDIAN HIMALAYA

A Glacier is a mass of ice, snow, water and rock debris flowing down a gradient. Based upon morphological characteristics of glaciers, they can be grouped into classes such as ice sheet, ice cap, and glacier constrained by topography. Ice sheet and ice cap are formed when underlying topography is fully submerged by ice and glacier flow is not influenced by topography. On the other hand, when glaciers are constrained by the surrounding topography and the shape of valley influences their flow, then such glaciers are classified as valley glaciers, cirque glaciers and ice fields. Mountain glaciers as in Himalayas, Alps, Andes are basically constrained by topography and are predominantly of valley type. In Himalayas, glaciers are distributed from West in Kashmir to East in Arunachal Pradesh covering entire stretch of Himachal Pradesh, Uttarakhand, Nepal and Sikkim Bhutan. The distribution and intensity of glaciation is governed by latitude and altitude of the mountains. The earliest map showing glacier boundaries of Himalayan mountains are available in Survey of India Topographical Maps of 1962.

During its geological history, the earth has experienced alternate cycles of warm and cold climates. During cold climate, glaciers and ice sheets have formed on the surface of the earth. Geological evidence suggests that the earth has experienced glaciations during, Perm-Carboniferous and in the Pleistocene period (Embleton and King, 1975). Precambrian tillites and boulder-beds are reported from many parts of the world, such as Scotland, U.S.A. Clear evidence of Carboniferous-Carboniferous ice age is also established in India and South Africa. The Carboniferous-Carboniferous glaciations was followed by Mesozoic era, during which the world temperature was higher than that of today and no evidence of glaciation was observed in the geological formations of that period. In Cenozoic era, large-scale glaciation was experienced, which includes glaciation during Pleistocene and Quaternary periods (Smith et. al., 2005). It has also influenced the present distribution of glaciers on the earth's surface. During Pleistocene the earth's surface had experienced repeated glaciation over a large land mass. During the peak of glaciation, the area covered by the glaciers was 46 million sq. km. (Embleton and King, 1975). This was more than three times the present ice cover of the earth. Available data indicates that during the Pleistocene, the earth has experienced four or five glaciation periods separated by an interglacial period. During an interglacial period, climate was warmer and deglaciation occurred on a large scale. The most recent glaciation reached its maximum advance about 20,000 years ago when the Himalayan snow line was depressed from 600 to 1000 meters lower than the present elevation due to fall of temperatures by 5 to 8ºC. At present total glaciated area on the earth is about 14.9 million sq. km. Out of this 2.5 million sq. km. is located in Arctic and 1.7 million sq. km in the Greenland ice sheet (Flint, 1971). The remaining 0.7 million sq. km area is distributed in the other parts of the World. Himalaya has one of the largest concentrations of glaciers outside the Polar Regions and some estimates suggest that the number could be as high as five thousand (Kulkarni and Bahuguna, 2001).

In the Himalaya, glaciers cover approximately 33000 sq. km. area, and this is one of the largest concentrations of glacier-stored water outside the Polar Regions. Melt water from these glaciers forms an important source into run-off of North Indian rivers during critical summer months. This makes these rivers perennial and has helped to sustain and flourish the Indian civilization along the banks of Ganga and Indus. This supply is available during dry periods and naturally regulates the flow of large rivers thus compensating extremes of precipitation. Glacial activity also generates sediments. However there have been several evidences in recent geological history about the glacier mass fluctuations resulting in the stream runoff originating from them. Stream runoff is an important component in planning of water resources and micro and mini hydroelectric projects. Glacier mass fluctuations are also indicators of global climatic changes. In the context of the Himalayan glaciers, which are source of many giant north Indian rivers, systematic monitoring of Himalayan glaciers is of paramount importance in view of their large number and area covered.

Global warming has already caused a significant glacier ice loss since the Little Ice Age (AD 1550-1850) (Denton and Hughes, 1981) resulting in both glacier retreat and thinning (loss of ice volume). Many glaciers in the Himalayan Mountain chain are reported to be gradually retreating (Mayeswki and Jeschke, 1979; Li et. al., 1998; Kulkarni and Bahuguna, 2002; Raina, 2004; Kulkarni and Alex, 2003; Kulkarni et. al., 2005; Kulkarni et al., 2006). Catastrophic natural processes triggered by these glacier changes were responsible for considerable death and destruction throughout the mountains. These processes included ice avalanches, landslides and debris flows, outbursts from moraine-dammed lakes and also outbursts from glacier dammed lakes. Glacier avalanches have occurred where glaciers have retreated up steep rock slopes. Sources of debris flows are frequently moraine complexes exposed during glacier retreat, which may be ice-cored. Outbursts from moraine dammed lakes result from the catastrophic breaching of the moraine dam - a process that is commonly initiated by glacier avalanches - generated waves that overtop the moraine. Himalayan and Trans-Himalayan glaciers are in general state of retreat since 1850 AD. Most of the Himalayan glaciers are covered by debris, which slows down their melting.

Glaciers in the Himalayas are fast retreating like other ice mountains the world over. A recent study showed that the last three decades of the 20th century have been the hottest period in 1,000 years. The melting of the Gangotri glacier is accelerating at an average retreat rate of 30 meters annually. The rate between 1935 and 1990 was 18 meters per year and 7 meters annually between 1842 and 1935. The overall deglaciation from 1962 to 2001 in the Baspa basin of Himachal Pradesh has been estimated as 19%. Chhota Shigri glacier of Chandra valley also retreated by about 12% in the last one and half decade. The deglaciation processes are also noticeable for large glaciers in Ganga headwater like Gangotri which shows about 10% decrease during the last 18 years. The maximum retreat of 34.5 meters per year has been observed at Meola glacier in Dhauliganga river basin. The retreat of the Parbati glacier is reported to be unusual and more alarming.

In the Himalayas, during the retreating phase a large number of lakes are being formed either at the snout of the glacier as a result of damming of the morainic material known as moraine dammed lakes or supra glacial lakes formed in the glacier surface area. A glacial lake is defined as a water mass existing in a sufficient amount and extending with a free surface in, under, beside and/or in front of a glacier and originated by glacier activities and/or retreating processes of a glacier. Most of these lakes are formed by the accumulation of vast amounts of water from the melting of snow and by blockade of end moraines located in the down valleys close to the glaciers. In addition, the lakes can also be formed due to landslides causing artificial blocks in the waterways. The sudden break of a moraine/block may generate the discharge of large volumes of water and debris from these glacial lakes and water bodies causing flash floods namely GLOF. A Glacial Lake Outburst Flood (GLOF), also known as a jökulhlaup in Icelandic (A jökulhlaup is technically a sudden and often catastrophic flood that occurs during a volcanic eruption, but is also used to describe other sorts of glacial flooding), can occur when a lake contained by a glacier or a terminal moraine dam fails. This can happen due to erosion, a buildup of water pressure, an avalanche of rock or heavy snow, an earthquake, or if a large enough portion of a glacier breaks off and massively displaces the waters in a glacial lake at its base. Many countries have a series of monitoring efforts to help prevent death and destruction that are likely to experience due to these events. The importance of this situation has magnified over the past century due to increased population, and the increasing number of glacial lakes that have developed due to glacier retreat. There are a number of GLOF events that have been reported worldwide. There are number of such events that have happened in Nepal Himalayas but no such event has been reported so far from Indian Himalayas. On the basis of mapping carried out in Himachal Himalayas in Satluj basin, there are about 38 such lakes in entire Satluj basin out of which 14 falls in Himachal part. Similarly, 50 moraine dammed lakes in Chenab basin and 5 supra glacial lakes have been mapped using remote sensing based on the studies carried out in the past.

The state of Himachal Pradesh invariably experiences flash floods, the cause of which is unknown. In the year 2000, the Satluj valley experiences the heaviest floods causing loss of more than 800 crores. It is still a matter of investigation weather the floods were caused by cloud bursting or due to Glacier Lake Outburst Floods (GLOF) phenomena. The formation of landslide dammed lakes in high altitude zones such as Parechhu in the upper catchment of Spiti basin in Tibet caused tremendous threat to the life and property located in the downstream areas. It is therefore necessary that a constant and repeated monitoring of the upper catchment areas having international dimensions required to be carried out on a regular basis.

The present study has been carried out with the help of remote sensing data. As with the modernization of technology, the application of Remote Sensing data in the mapping of Natural Resources like the land use/land cover, ground water targeting, mineral resources, urban planning, disaster management, flood protection, and monitoring of glacier lake out burst's floods and the snow cover studies are gaining importance day by day in the world. Since this technology helps in having the synoptic coverage of any desired area and having better spatial resolution, it can be used as a very effective tool for planning and development. With the advancement of the technology, now it has become possible even to map an object of less than one meter in its dimensions. This technology attains significant importance when the area under investigation is inaccessible as in the present case where the monitoring of glacial lakes formed in the upper catchments is not possible by any other conventional method, so this technology has been successfully used for the mapping and monitoring of such water bodies in the entire Satluj catchment right from Mansarover to downstream up to Nathpa in Kinnaur district of Himachal Pradesh. In this study a total of 197 lakes which were identified earlier by the National Remote Sensing Agency Hyderabad were considered as the base line data for the year 2007 and since 2009 the State Council for Science Technology & Environment has been monitoring all such lakes in the entire Satluj catchment during the ablation period regularly for Satluj Jal Vidyut Nigam Ltd Shimla as part of their disaster management plan. Besides this the main threat i.e., the Parechhu lake has been monitored regularly and the water spread status of the lake during 2018 was assessed and the conveyed to the State Government as well as to the SJVNL. Besides this during the year 2017, all glacial lakes/water bodies have been monitored using IRS/AWIFS satellite data as well as IRS RS2-LISS-III satellite data for the entire catchment and water spread has been compared with that of the water spread area during 2017 for both AWIFS and LISS -III satellite data.

2.2 DISTRIBUTION OF GLACIAL LAKES IN HIMACHAL HIMALAYA

Based on the IRS-RS2-LISS-III satellite data having spatial resolution of 23.5mts and Landsat 8 MSS satellite data having spatial resolution of 30mts for the year 2019, the study area was analysed in order to make an updated inventory of moraine dammed glacial lakes known as GLOFs (Glacial Lake Outbursts Floods) in Himachal Himalaya comprising the Satluj, Chenab, Beas and Ravi basins. The Satluj basin has been studied in detail right from its origin from the Tibetan Himalaya, whereas the other basins have been analysed for their areas of interest in Himachal Pradesh.

The results based on the analysis thus obtained reveals that in Satluj basin, a total of 562 lakes from the Satluj catchment covering 8 satellite imageries (96-48,96-49,97-48,97-49,98-48,98-49,99-49,100-49) having spatial resolution of 23.5 mts. have been mapped during 2019. Further based on the LISS-III satellite data analysis for *2019* in Satluj basin, a total of 562 lakes have been delineated out of which about 81% (458) lakes are the small one with area less than 5ha, about 9% (53) falls within the aerial range of 5-10ha and about 9% (51) are the big one with area more than 10ha. The comparative analysis based on LISS III data reveals that total number of lakes in the Satluj catchment varies from 642 (2017) to 769 (2018) to 562 (2019) reflecting an overall increase of about 19% between 2017-18 and a reduction of about 26% between 2018-19, which is mainly due to the non-availably of good quality LISS III data products in 2019. Out of the 562 lakes/wetlands mapped in 2019 using LISS III satellite data, basin 1 i.e., Spiti basin constitutes about 12% (73) of the total lakes mapped (562) which is about 58% less than 2018 (176). Likewise, basin 2 i.e., the Lower Satluj basin constitutes 9% (52) of the total lakes mapped which is about 46% less than 2018(98) and the Upper Satluj basin i.e., the basin 3 constitutes of 77% (437) lakes in 2019 which is about 11% less than 2018 (495).

As far as the big lakes based on LISS III satellite data is concerned, the analysis reveals that the number varies from 52 (2017) to 49 (2018) to 51 (2019) reflecting an overall increase of about 4% between 2018-19. The Parechhu Lake in the Tibetan Himalayan Region was also monitored separately during the ablation period of 2019 and does not show any major change in its water spread and seems to be stable based on the observations made which have been reported to SJVNL as well as to the Government during 2019. Besides this, the landslide on the upstream side of the lake depression was also monitored in order to assess any change in the water level by virtue of the landside which may block the river course causing major threat like that of the Parechhu formation during the year 2004.

Along the course of main Satluj River, few isolated pockets have also been observed which shows accumulated water in the upper catchment of the Tibetan Himalayan Region and within the Spiti basin i.e., sub basin 1. In Spiti basin the lakes with ids 1682RS (0.40ha), 1683RS (1.09ha), 1684RS (1.95ha), 1685RS (1.44ha), 1686RS (1.59ha) and 1687RS (1.57ha) are some of the water bodies which have been developed along the nala section coming along the village Chicham just upstream of Kaza on the left bank formed in series. All these water bodies are although small but needs monitoring as this is along the river course and can cause major damage in case if it bursts. Thus, the lakes/water bodies coded with abbreviation *RS* with their ids are some of the locations where accumulated water could be seen and these are the permanent features which needs regular monitoring in order to assess any temporal changes in their behaviour in the time to come.

Table 2.1: Distribution of lakes in different sub basins in Himachal Pradesh based on LISS III satellite data analysis for 2019

Sr. No	Name of the basin	No. of lakes with area>10ha	No. of lakes with area between5-10ha	No. of lakes with area<5ha	Total No. of lakes
1	**Chenab**	**04(2018)05(2019)**	**10(2018)11(2019)**	**240(2018) 226(2019)**	**254(2018) 242(2019)**
	Bhaga	01(2018)02(2019)	04(2018)03(2019)	79(2018) 46(2019)	**84(2018) 51(2019)**
	Chandra	02(2018)02(2019)	03(2018)03(2019)	59(2018) 47(2019)	**64(2018) 52(2019)**
	Miyar	01(2018)01(2019)	03(2018)05(2019)	102(2018) 133(2019)	**106(2018) 139(2019)**
2	**Beas**	**03(2018) 04(2019)**	**04(2018) 4(2019)**	**58(2018) 85(2019)**	**65(2018) 93(2019)**
	Jiwa	00(2018)00(2019)	00(2018)00(2019)	15(2018) 41(2019)	**15(2018)41(2019)**

	Parvati	03(2018) 03(2019)	01(2018)02(2019)	23(2018) 32(2019)	**27(2018)37(2019)**
	Beas	00(2018)01(2019)	03(2018) 02(2019)	20(2018)12(2019)	**23(2018)15(2019)**
3	**Ravi**	**03(2018) 01(2019)**	**02(2018)02(2019)**	**61(2018)34(2019)**	**66(2018)37(2019)**
4	**Satluj**	**49(2018)51(2019)**	**57(2018) 53(2019)**	**663(2018)458(2019)**	**769(2018)562(2019)**

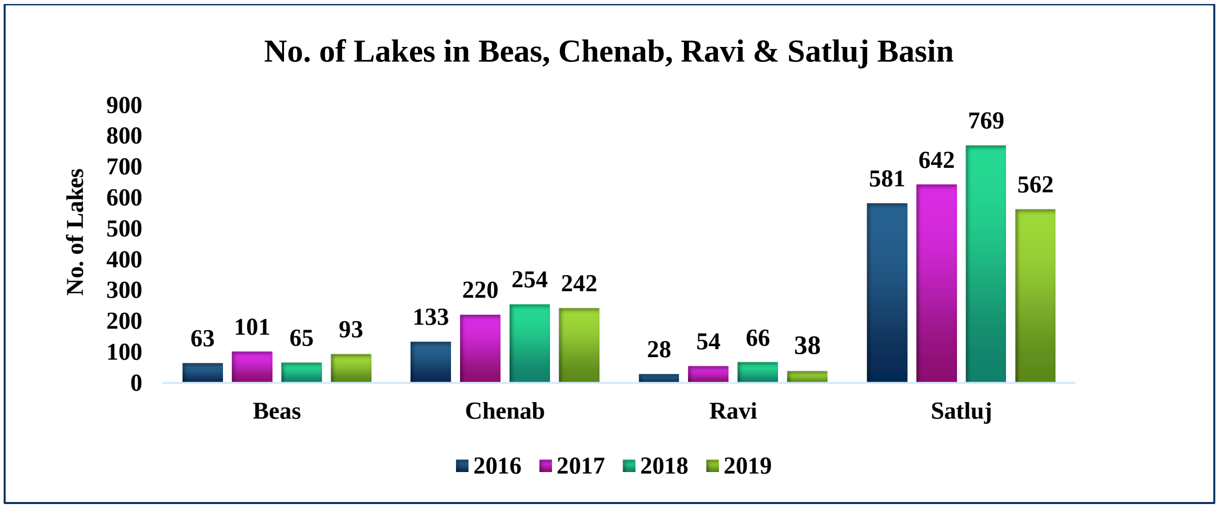


Fig. 2.1: Distribution of lakes in Chenab, Beas, Ravi & Satluj basin

2.2.1. DISTRIBUTION OF LAKES WITH AREA MORE THAN 10HA

Based on the satellite data interpretation for the year 2019, the study area has been studied to understand the temporal variation of all such lakes with area more than 10ha. In Satluj basin the total number of such lakes has increased from 40 (2013) to 42 (2015) to 55 (2016) to 52 (2017) to 49 (2018) to 51 (2019) respectively based on LISS III satellite data. Likewise in other basins, i.e., in Chenab, the number of lakes varies from 3 (2013) to 4 (2015) to 2 (2016), 5 (2017) to 4 (2018) and 5 (2019). In Beas basin the number varies from 2 (2013) to 2 (2015) to 3 (2016) to 4 (2017) to 3 (2018) and 4 (2019). In the Ravi basin, the number of lakes varies from 2 (2013) to 3 (2015) to 3(2016) to 3 (2017) and 3 (2018) respectively. The lakes with HWL are mainly the high-altitude wetlands in high altitude regions.

Table 2.2: Distribution of lakes with area more than 10ha in different sub basins in Himachal Pradesh based on LISS III satellite data analysis

Sr. No.	Lake Id.	2015	2016	2017	2018	2019
			Bhaga			
1	6	----	6.21	10.23	9.92	10.94
2	11	10.39	7.92	9.84	11.21	10.40
			Chandra			
3	1	90.51	90.18	115.51	95.03	98.68
4	3	151.42	131.58	179.64	160.99	162.07
			Miyar			
5	209	----	----	16.08	15.06	15.97
			Jiwa			
	----	----	----	----	----	----
			Parvati			
1	21	12.68	13.81	12.88	13.14	14.56
2	26	13.52	11.28	15.47	13.82	15.21
3	50	----	10.01	14.58	13.30	11.83
			Upper Beas			
4	6	----	7.54	10.86	9.82	10.47
			Ravi			
1	10	16	12.05	14.42	14.63	----
2	16	30.97	27.28	34.50	11.35	----
3	31	11.72	11.2	12.16	12.38	----
			Satluj			
1	49HWL	23	----	----	38	24.58
2	67	12	13.04	8.06	8	24.58
3	85	----	----	----	----	34.89
4	86	9	10.88	10.11	10.06	10.10
5	87	9	10.06	9.38	10.5	10.41
6	99	19	18.37	17.12	18.8	14.72
7	101	24	24.65	21.37	22.8	21.10
8	122	7	16.16	15.34	16.5	16.86
9	173	3	9.32	7.65	----	13.20
10	184	----	----	----	----	23.32
11	209	33	36.38	----	----	33.76
12	145(HWL)	41584	41646.22	41498.50	41233.9	41640.43
13	179	25	26.26	25.07	25.6	24.26
14	184	27	19.51	19.15	25.5	19.96
15	210(HWL)	57	64.32	59.43	59.17	63.72
16	894	10	----	9.90	9.7	10.15
17	1063HWL	45	39.79	----	----	44.09
18	138(HWL)	26065	26538.79	25891.56	25634.8	25920.91
19	178	205	190.71	204.05	206.39	201.14
20	181	13	13.72	18.07	19.28	12.39
21	1093(HWL)	5515	5676.31	5787.38	5854.36	5992.49
22	1094HWL	16	13.83	12.82	12.62	14.85
23	1128	23	24.45	23.95	25.14	25.00
24	1133	17	15.23	16.09	15.86	16.18
25	1153	63	64.41	66.74	69.2	74.10
26	1155	16	16.38	16.14	17.47	14.27

27	1156(HWL)	11	11.85	11.56	11.69	11.74
28	1164	15	15.12	14.94	14.86	16.08
29	1092HWL	----	14.69	13.63	----	14.13
30	1363HWL	----	28.25	17.77	----	22.24
31	1375HWL	----	47.91	43.26	----	28.96
32	1510	----	54.52	54.37	54.38	52.93
33	1512	----	23.53	23.62	24.23	21.47
34	1518	----	13.78	12.53	14	12.19
35	1527	----	11.17	10.47	11.43	11.37
36	1548	----	17.95	14.62	19.91	17.41
37	1557RS	----	69.88	96.36	80.87	92.85
38	1349HWL	----	352.60	292.13	322.95	335.79
39	1095(HWL)	----	17.26	14.31	15.58	17.22
40	1565	----	16.38	18.11	17.36	19.13
41	1566(HWL)	----	22.81	24.35	18.76	10.77
42	1782(HWL)	----	----	----	29.1	30.65
43	1774RS	----	----	----	11.69	12.93
44	1771RS	----	----	----	12.22	14.99
45	1776RS	----	----	----	----	13.98
46	1654	----	----	----	----	22.28
47	2180	----	----	----	----	23.56
48	1039HWL	----	----	----	----	12.16
49	1144HWL	----	----	----	----	89.47
50	2167HWL	----	----	----	----	214.31
51	1146	----	----	----	----	10.60

(HWL-High Altitude Wetlands)

(RS-River Section)

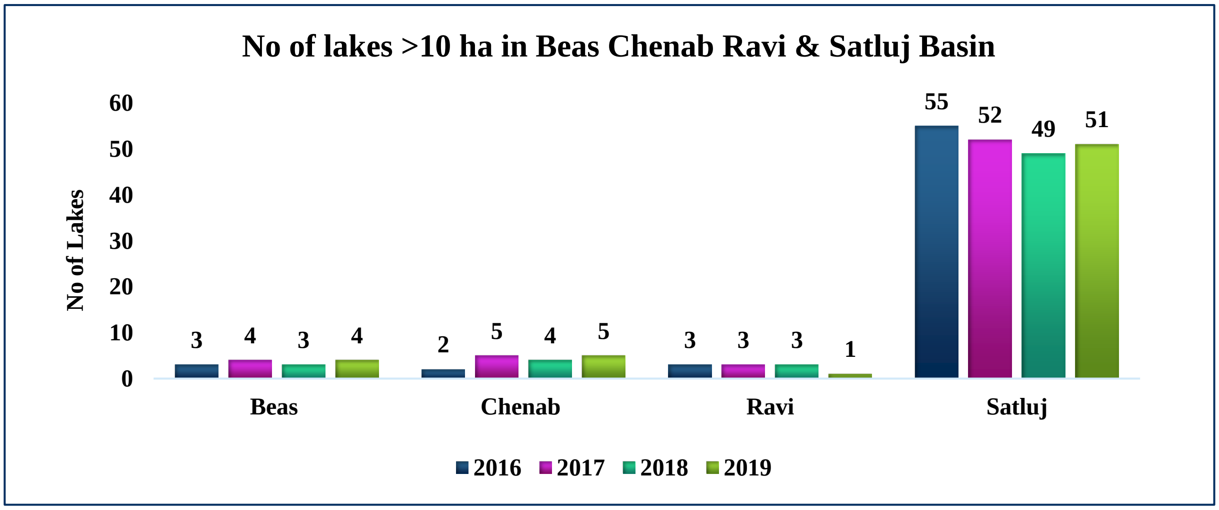


Fig. 2.2: Distribution of lakes with area >10 Ha in Beas, Chenab, Ravi & Satluj basin in 2016- 2019

3. OBJECTIVES OF THE PRESENT STUDY

The main objectives of the study are to monitor the water spread area of the all the moraine dammed glacier lakes/ water bodies on monthly basis in the entire Satluj Basin during April to November 2023 based on the inventory of the lakes during the preceding year prepared using space data.

3.1 STUDY AREA AND DATA USED

The investigations have been carried out in the Satluj basin right from its origin from the Mansarover Lake in Tibetan Region. The river Satluj is one of the main tributaries of Indus and has its origin near Mansarover Lake and Rakes Tal in Tibetan Plateau at an elevation of about 4,500 m (approx.). The study area has been divided into three major sub basins i.e., Spiti as sub basin number 1, Lower Satluj as sub basin number 2 and Upper Satluj in Tibet catchment as basin 3 (Fig 3.1). The Satluj River travels about 300 km (approx.) in Tibetan plateau in North-Westerly direction and changes direction towards South-West and covers another 320 km.(approx.) up to Bhakra gorge where 225m high straight gravity dam has been constructed. This western Himalayan basin is highly rugged terrain with abundant natural water resource in the form of snow pack. The Satluj basin is geographically located between 30° 00' N, 76° 00' E and 33° 00’ N, 82° 00’ E. The Nathpa dam is a 62.5 m high concrete dam located on Satluj River at Nathpa. The dam is a main component of the 1,500 MW Nathpa Jhakri Hydro-Electric Project – NJHEP. The project is located in the state of Himachal Pradesh and derives its name from the names of two villages in the project vicinity - Nathpa in Kinnaur district and Jhakri in Shimla district - in the interiors of Himachal Pradesh. The project was conceived as a run-of-river type hydro power development, harnessing hydro-electric potential of the middle reaches of the river Satluj. The project's dam has been constructed near village Nathpa and its power house has been constructed on the left bank of the river Satluj at village Jhakri. The project stretches over a length of about 50 Km from the dam site to the power house site, on the Hindustan- Tibet Road (NH-22). Characteristics of the Satluj basin and inaccessibility of the major part of it make remote sensing application ideal for hydrologists to monitor glacial lakes and water bodies in the basin (Fig. 3.1). Most of the area in the present study falls in the inaccessible high mountain region of Himalayas (Fig. 3.2). Hence, the monitoring of glacial lakes / water bodies was done using remote sensing method. The images acquired by AWiFS (Advanced Wide Field Sensor) sensor, LISS III and LISS IV of IRS-RS2 & RS2A (Indian Remote Sensing) Satellite were used in the present study. The path–row of satellite coverage is shown in (Fig. 3.3). Table 3.1 shows the satellite data used for the study purpose during 2023.

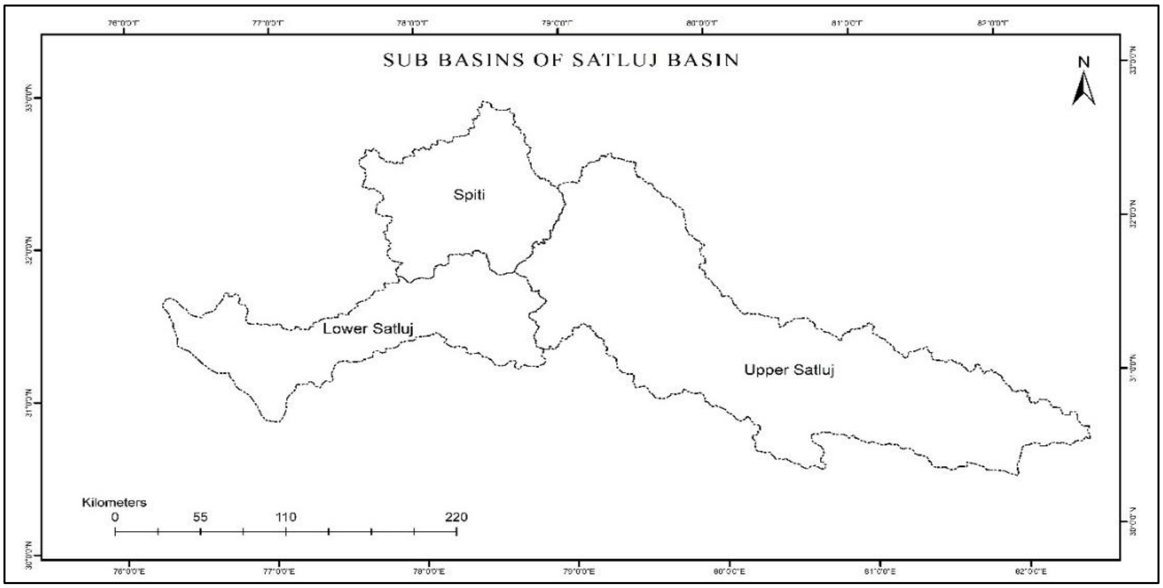


Fig. 3.1: Different regions in Satluj basin

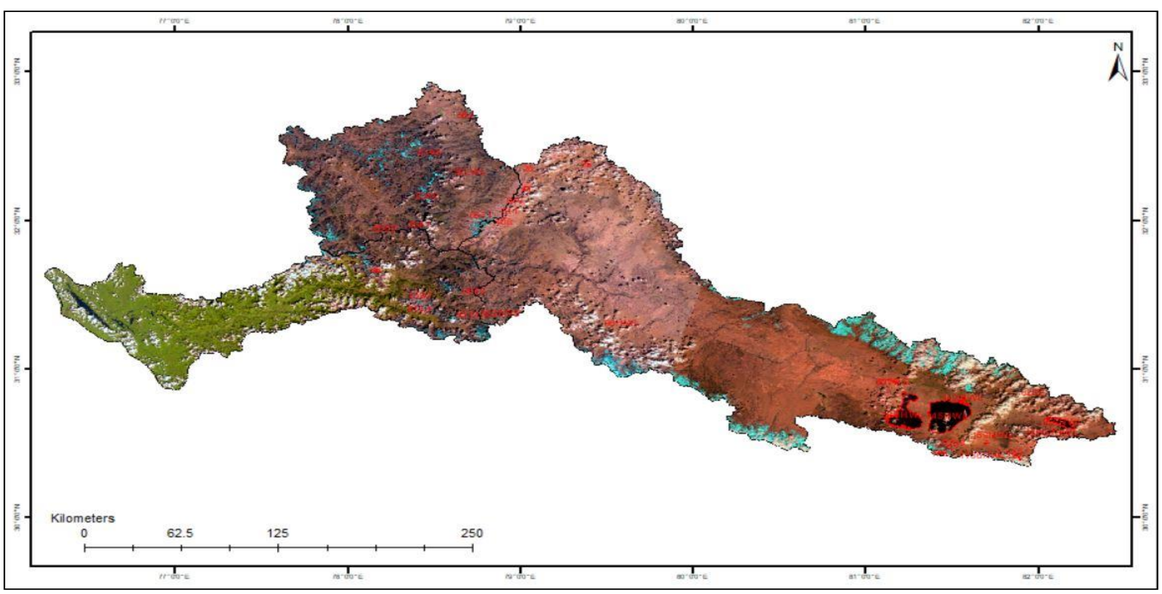


Fig. 3.2: False Colour Composite of Satellite images covering Satluj basin

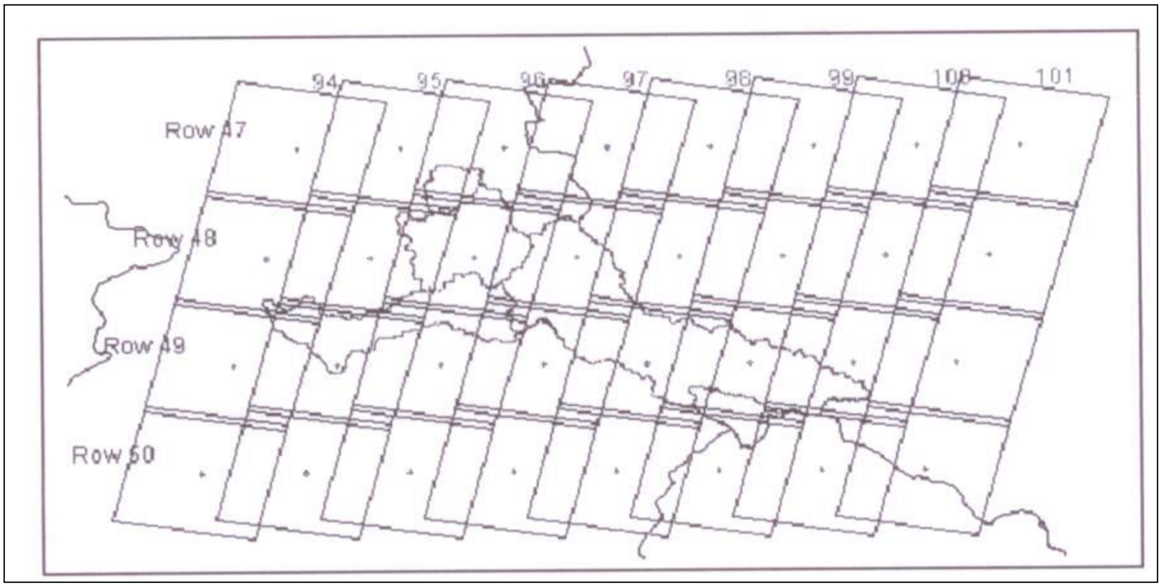


Fig. 3.3 IRS-P6 LISS-III Data Coverage over Satluj Basin

Table 3.1: Satellite data used for monitoring in the study area

AWiFS Satellite data used for monitoring in the study area			
Sr. No.	**Date of Pass**	**Path –Row**	**Satellite Sensor**
1	11 Apr 2023	98-49	Resourcesat2/AWIFS
2	29 May 2023	98-46	Resourcesat2/AWIFS
3	29 May 2023	98-51	Resourcesat2/AWIFS
4	17 June 2023	97-50 a	Resourcesat2/AWIFS
5	17 June 2023	97-50 b	Resourcesat2/AWIFS
6	16 July 2023	98-48	Resourcesat2/AWIFS
7	16 Aug 2023	97-47	Resourcesat2A/AWIFS
8	28 Aug 2023	97-47	Resourcesat2/AWIFS
9	31 Aug 2023	100-51	Resourcesat2A/AWIFS
10	02 Sep 2023	98-48	Resourcesat2/AWIFS
11	04 Sep 2023	96-47	Resourcesat2A/AWIFS
12	12 Sep 2023	100-48	Resourcesat2/AWIFS
13	14 Sep 2023	98-47	Resourcesat2A/AWIFS
14	26 Sep 2023	98-47	Resourcesat2/AWIFS
15	05 Oct 2023	95-48	Resourcesat2/AWIFS
16	06 Oct 2023	100-48	Resourcesat2/AWIFS
17	15 Oct 2023	97-47	Resourcesat2/AWIFS
18	13 Nov 2023	98-47c	Resourcesat2/AWIFS

19	13 Nov 2023	98-48d	Resourcesat2/AWIFS
20	13 Nov 2023	98-49b	Resourcesat2/AWIFS
21	13 Nov 2023	98-47c	Resourcesat2/AWIFS
22	13 Nov 2023	98-48d	Resourcesat2/AWIFS
LISS-III Satellite data used for monitoring in the study area			
Sr. No.	**Date of Pass**	**Path –Row**	**Satellite Sensor**
1	04 Sep 2023	96-48	Resourcesat2A/LISS III
2	28 Sep 2023	96-48	Resourcesat2A/LISS III
3	28 Sep 2023	96-49	Resourcesat2A/LISS III
4	16 Aug 2023	97-48	Resourcesat2A/LISS III
5	28 Aug 2023	97-48	Resourcesat2/LISS III
6	21 Sep 2023	97-48	Resourcesat2/LISS III
7	03 Oct 2023	97-48	Resourcesat2A/LISS III
8	16 Aug 2023	97-49	Resourcesat2A/LISS III
9	28 Aug 2023	97-49	Resourcesat2/LISS III
10	21 Sep 2023	97-49	Resourcesat2/LISS III
11	03 Oct 2023	97-49	Resourcesat2A/LISS III
12	09 Aug 2023	98-48	Resourcesat2/LISS III
13	08 Oct 2023	98-48	Resourcesat2A/LISS III
14	02 Sep 2023	98-48	Resourcesat2/LISS III
15	14 Sep 2023	98-48	Resourcesat2A/LISS III
16	26 Sep 2023	98-48	Resourcesat2/LISS III
17	08 Oct 2023	98-49	Resourcesat2A/LISS III
18	14 Sep 2023	98-49	Resourcesat2A/LISS III
19	21 Aug 2023	98-49	Resourcesat2A/LISS III
20	26 Sep 2023	98-49	Resourcesat2/LISS III
21	02 Sep 2023	98-49	Resourcesat2/LISS III
22	26 Aug 2023	99-49	Resourcesat2A/LISS III
23	01 Oct 2023	99-49	Resourcesat2/LISS III
24	13 Oct 2023	99-49	Resourcesat2A/LISS III
25	12 Sep 2023	100-49	Resourcesat2/LISS III
26	31 Aug 2023	100-49	Resourcesat2A/LISS III
27	24 Sep 2023	100-49	Resourcesat2A/LISS III
28	06 Oct 2023	100-49	Resourcesat2/LISS III
29	18 Aug 2023	95-47	Resourcesat2/LISS III
30	05 Oct 2023	95-48	Resourcesat2/LISS III
31	30 Aug 2023	95-47	Resourcesat2A/LISS III

32	07 Sep 2023	99-48	Resourcesat2/LISS III
33	30 Aug 2023	95-48	Resourcesat2A/LISS III
LISS-IV Satellite data used for monitoring in the study area			
Sr. No	**Date of Pass**	**Path- Row**	**Satellite Sensor**
1	05 Oct 2023	95-48a	Resourcesat2/LISS IV
2	05 Oct 2023	95-48c	Resourcesat2/LISS IV
3	11 Sep 2023	95-48b	Resourcesat2/LISS IV
4	11 Sep 2023	95-48d	Resourcesat2/LISS IV
5	04 Sep 2023	96-48a	Resourcesat2A/LISS IV
6	28 Sep 2023	96-48b	Resourcesat2A/LISS IV
7	28 Sep 2023	96-48d	Resourcesat2A/LISS IV
8	28 Sep 2023	96-49b	Resourcesat2A/LISS IV
9	21 Sep 2023	97-48c	Resourcesat2/LISS IV
10	21 Sep 2023	97-49a	Resourcesat2/LISS IV
11	21 Sep 2023	97-49c	Resourcesat2/LISS IV
12	03 Oct 2023	97-49d	Resourcesat2A/LISS IV
13	26 Sep 2023	98-48c	Resourcesat2A/LISS IV
14	03 Oct 2023	97-48d	Resourcesat2A/LISS IV
15	26 Sep 2023	98-49a	Resourcesat2/LISS IV
16	08 Oct 2023	98-49b	Resourcesat2A/LISS IV
17	26 Sep 2023	98-49c	Resourcesat2/LISS IV
18	03 Oct 2023	97-49b	Resourcesat2A/LISS IV
19	08 Oct 2023	98-49d	Resourcesat2A/LISS IV
20	14 Sep 2023	98-49d	Resourcesat2A/LISS IV
21	06 Oct 2023	100-49c	Resourcesat2/LISS IV
22	01 Oct 2023	99-49a	Resourcesat2/LISS IV
23	13 Oct 2023	99-49a	Resourcesat2A/LISS IV
24	01 Oct 2023	99-49c	Resourcesat2/LISS IV
25	13 Oct 2023	99-49c	Resourcesat2A/LISS IV
26	25 Oct 2023	99-49b	Resourcesat2/LISS IV
27	25 Oct 2023	99-49d	Resourcesat2/LISS IV
28	07 Sep 2023	99-49d	Resourcesat2/LISS IV
29	06 Oct 2023	100-49a	Resourcesat2/LISS IV
30	12 Sep 2023	100-49b	Resourcesat2A/LISS IV
31	24 Sep 2023	100-49b	Resourcesat2A/LISS IV
32	12 Sep 2023	100-49d	Resourcesat2/LISS IV
33	24 Sep 2023	100-49d	Resourcesat2A/LISS IV

34	4 Sep 2023	96-47c	Resourcesat2/LISS IV
35	28 Sep 2023	96-47d	Resourcesat2A/LISS IV
36	03 Oct 2023	97-48b	Resourcesat2/LISS IV
37	21 Sep 2023	97-48a	Resourcesat2/LISS IV
38	4 Sep 2023	96-48c	Resourcesat2A/LISS IV

4. METHODOLOGY

The satellite data covering Satluj basin during the months of April to November 2023 was browsed. The cloud free AWiFS satellite data for the year 2023 for monitoring of lakes during 2023 and the LISS-III & LISS –IV images for further monitoring based on high resolution data for the year 2023 from IRS-RS2 &RS2-A satellite were procured. With the spatial resolution of AWiFS (56 m) the monitoring of lakes was done by identifying all the water bodies irrespective of their aerial extent and was compared with that of the lake area mapped during 2022 from AWiFS satellite data.

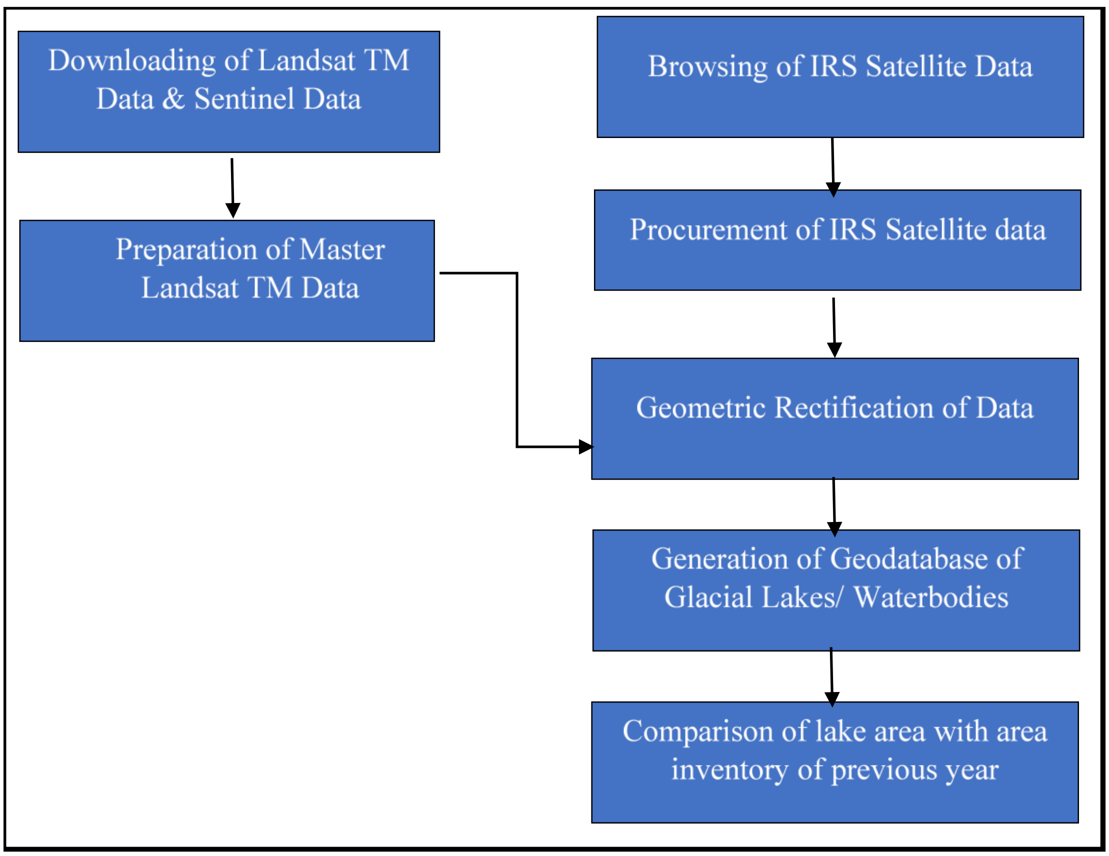


Fig. 4.1: Flow Chart Methodology

Each of these satellite data sets was individually rectified with the reference image master AWiFS data sets. The geometric rectification was done using polynomial transformation of third order with resulting Root Mean Square (RMS) error less than one pixel. The Satluj river basin boundary is superimposed on the satellite image of the basin and the lakes which are visible and clearly demarkable were delineated using ERDAS software. The lake boundaries were digitized using ERDAS /Imagine vector module tools. The digitized polygons have been cleaned for open ends and built into a polygon layer. All the polygons have been assigned polygon ID's. Water spread area is considered to represent the boundary of lake. The process of procurement of satellite data, geometric rectification, lake area digitization and comparison are repeated for all the data sets during April to November 2023. The flowchart explaining the methodology is given in (Fig. 4.1).

Besides this, as the AWiFS has the spatial resolution of 56 mts. the lake inventory prepared using LISS-III has the spatial resolution of 23.5 meter, was compared with that of an updated inventory using high resolution LISS-III satellite data for the year 2023. All the cloud free satellite images for the month of July to September 2023 were selected for making an updated inventory and were compared for their spatial variation with respect to that for the year 2022. The methodology adopted is same as that of the AWiFS data product in the study area and the following LISS III satellite data has been used for updating the inventory in the entire Satluj Basin.

During the year 2023, another set of databases based on very high resolution of 5.8 mts. from LISS IV sensor was prepared. Using LISS IV sensor data, it has become possible all such lakes which could not be mapped in LISS III and thus gives a highly accurate information of the even smaller lakes which are coming up in the high-altitude region of the Satluj catchment. This database thus prepared was compared with that of the baseline data generated for 2022 for having a real time temporal analysis of the glacial lakes in the region. The methodology adopted is same as that of the AWIFS data product in the study area and the following LISS III satellite data has been used for updating the inventory in the entire Satluj Basin.

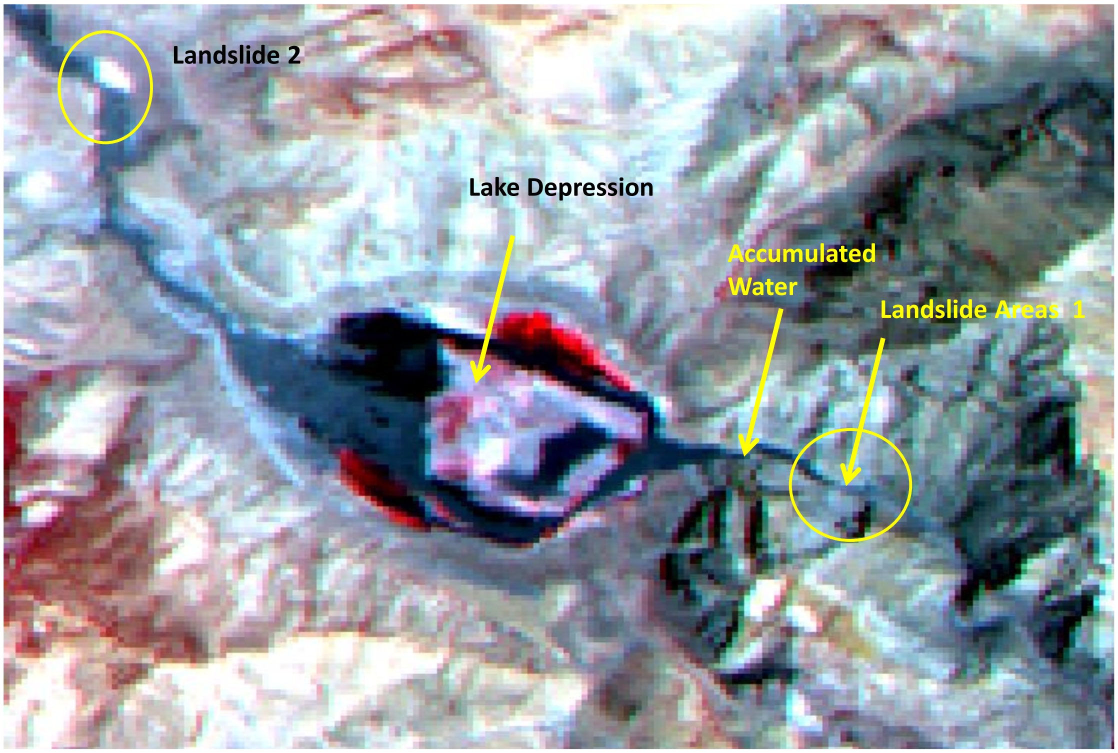
5. MONITORING OF PARECHHU LAKE DURING 2023

Parechhu Lake is a small geomorphic depression along the Parechhu River that joins the Spiti River on its left bank near Sumdo in Spiti Sub Division of District Lahaul & Spiti. The fragile geology of the area and the Sumdo Kaurik fault passing nearby cause's activation of the landslides which results in chocking of the river course in the downstream and causes accumulation of the water in the depression. This lake has been known for its damage history and since 2001 is being monitored every year during the ablation season from April to September During the year 2023, the lake was regularly monitored and its findings about the water spread were reported to the SJVNL as well as to the Government.

5.1 OBSERVATIONS DERIVED FROM THE SATELLITE DATA ANALYSIS DURING 2023:

Based on the analysis of IRS-R2-L3-97-48- 04 August 2023 high resolution satellite data having spatial resolution of 23.5 mts., the following observations are made: -

- The accumulated water in the lake depression could be seen along the periphery of the depression and extending downstream up to the point where landslide seems to have caused slight blockade of the river course i.e., about 727.26 mts. from the lower point of the lake depression.
- Slight accumulation could also be seen along the braded channels in the upper part along with a small patch on the frontal part of the depression.
- Based on the tonal difference in the river flow, near the landslide 1, the slide seems to have caused a slight blockade in the river course could be seen resulting to have the accumulation of the water along the stream that extends upwards all along the peripheral side in the frontal portion of the lake depression.



Parechhu Lake as seen through IRS-R2-L3-97-48-04 August, 2023

Fig. 5.1: Status of Parechhu Lake as on August 2023

- The effects of the landslide number 2 on the upper part along the Parechhu River could also be seen reflecting some accumulation along the river course.
- The inflow and outflow seem to be comparatively normal as on 4th August 2023 except slight accumulation in the outflow near the landslide 1.
- Based on the satellite image, the landslide may affect the outflow in the frontal part and inflow from the upper part needs to be monitored regularly in the coming months in view of present status and the melting of the snow cover from the higher catchments in the coming months.
- As such based on the satellite data interpretation for the month from 4th August 2023, there does not seem to be any threat from the Parechhu Lake as on day, but needs regular monitoring as the ablation process is still undergoing and also needs the landslide monitoring in order to assess any further changes in the river flow/ blockade etc.

6. MONITORING OF GLACIAL LAKES AND OTHER WATER BODIES USING AWIFS SATELLITE DATA IN SATLUJ CATCHMENT DURING 2023

Based on the satellite data analysis for the period January to December 2007 on monthly basis, the total 197 lakes which were identified by the National Remote Sensing Agency Hyderabad earlier using satellite data for the year 2007 were used as the base line data. Thereafter all these 197 lakes were further analysed and monitored for the year 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022 and 2023. In the present study the lakes which were mapped during 2022have been used to assess the temporal variation with that of the lakes mapped during the preceding years. The status of lakes mapped during 2023 and their temporal variation with respects to 2022 is as per the following observations derived from the AWiFS satellite data analysis using visual interpretation techniques. The lakes which are fully visible in the satellite image and the lake boundaries are clearly remarkable, only in such cases the lake is mapped and its area computed. In cases where the lakes are under fully/partly cloudy shadow or fully/partly cloudy covered or fully/partly snow covered the areas of such lakes are not reported. Further the lakes have been categorized into two categories i.e., one which are having their origin from the glaciated terrains i.e., near or in front or within the glacier bodies, are known as the moraine dammed glacial lakes or supra glacial lakes, whereas the other category is that of all the lakes which are formed within the depressions are classified as high-altitude wetlands formed in the Tibetan region because of the one or the other reason.

6.1 STATUS OF LAKES AS ON APRIL 2023

During April 2023, only data product for 11th April 2023 could be obtained of AWiFS (Fig: 6.1 (a)) having its maximum area under the impact of seasonal snow. The interpretation of satellite data reveals presence of 42 lakes comprising 3 lakes from Spiti and 2 lakes from Lower Satluj i.e., sub basin number 1 & 2 and 37 lakes from the Upper Satluj basin i.e., sub basin number 3 (Fig: 6.1 (c)). Further detailed analysis reflects those 11 lakes identified are smaller with area less than 5 ha in upper Satluj Basin, 11 lakes are with areal range 5-10 ha and 20 lakes are with area greater than 10 ha (Fig: 6.1(c)). Further analysis of 42 lakes reveals that 20 lakes are the high-altitude wetlands falling in the Upper Satluj basin. Based on the areal distribution of these 20 high altitude wetlands, 11 are with area more than 10 ha, 5 lies within range of 5 - 10 ha and 4 with area less than 5 ha (Fig: 6.1(d)). Besides this, out of 42 lakes, 7 lakes have been formed along the different river sections with ids RS (Table 6.1).

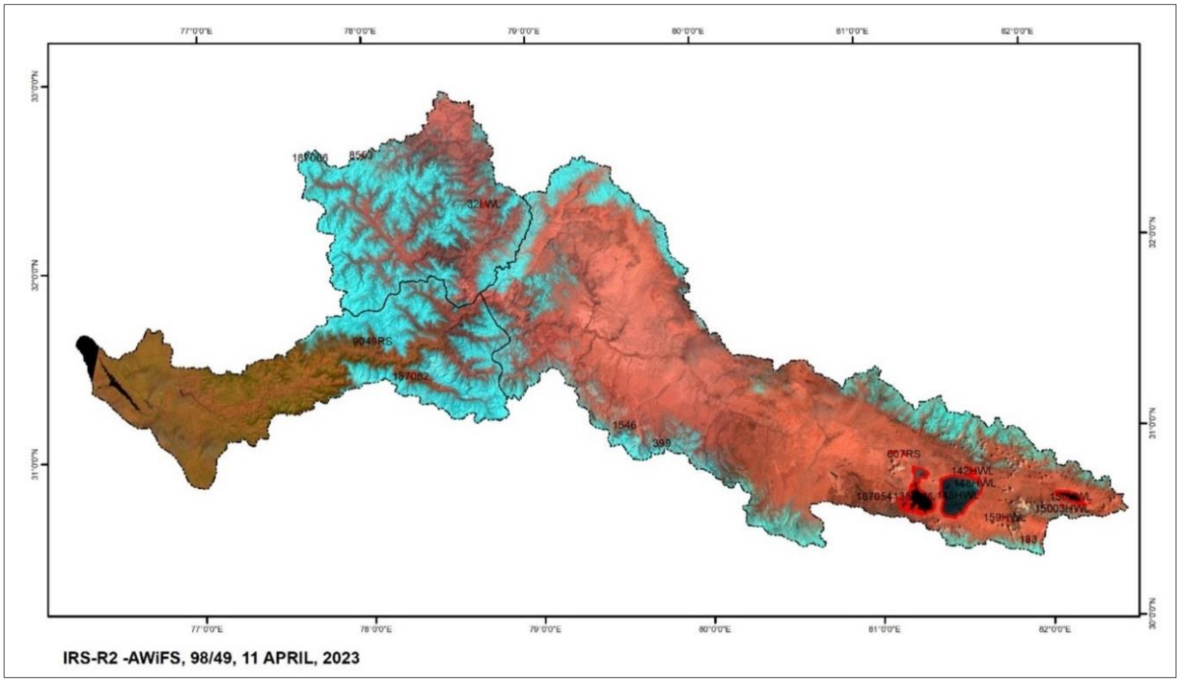


Fig. 6.1 (a): IRS-R2 -AWiFS, 98/49, 11th April, 2023

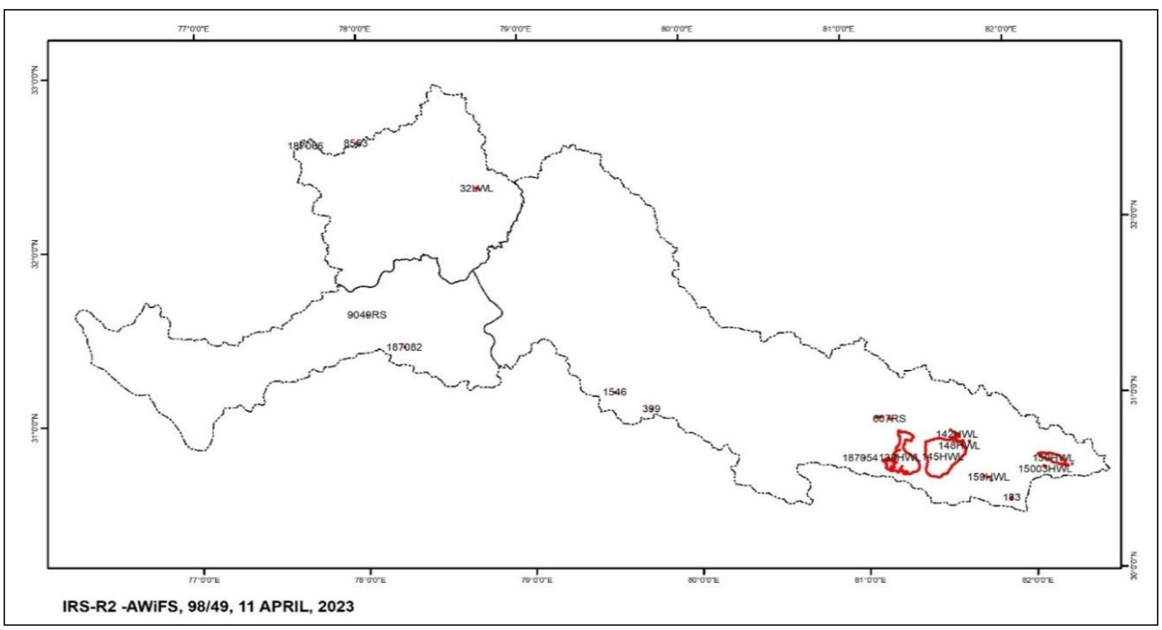


Fig. 6.1 (b): IRS-R2 -AWiFS, 98/49, 11th April, 2023, Interpreted layers

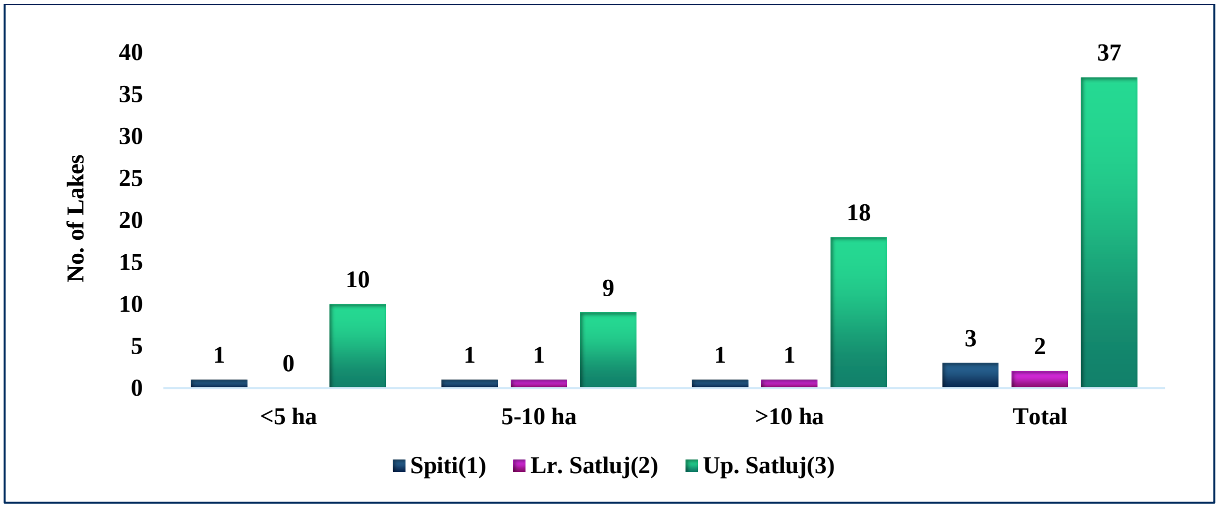


Fig. 6.1 (c): No. lakes based on IRS-R2 -AWiFS, 98/49, 11th April, 2023

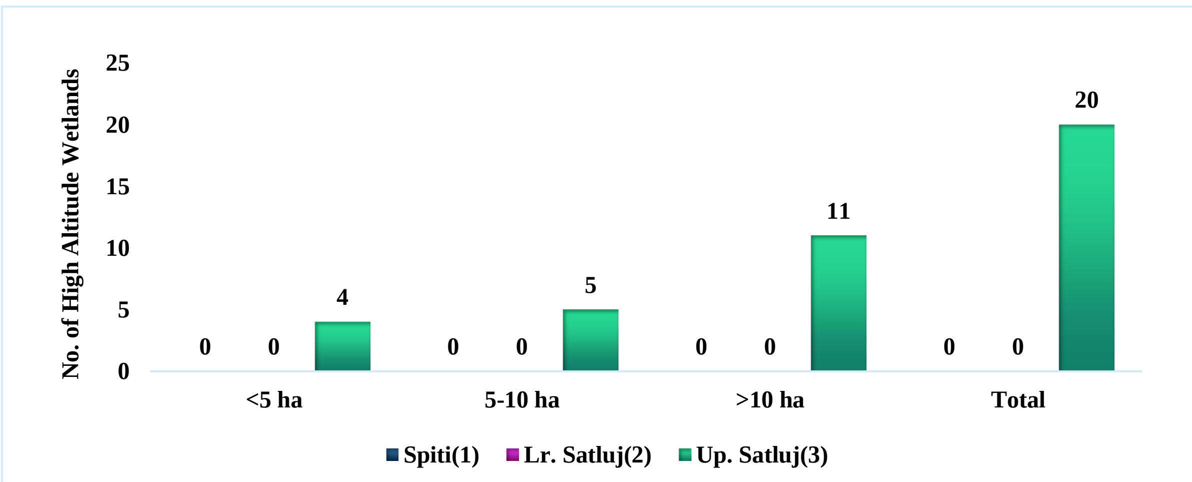


Fig. 6.1 (d): No. of high wetland lakes based on IRS-R2 -AWiFS, 98/49, 11th April, 2023

Table: 6.1 Aerial extent of lakes as on April, 2023

S. No.	Lake Id.	Basin No.	Latitude	Longitude	Aerial Extent on April 2023 (Ha.)	Aerial Extent on Sept 2022 (Ha.)	Change in Area w.r.t. Sept. 2022 (ha.)
1	**183**	**3**	**30.43**	**81.87**	**24.30**	**--------**	**--------**
2	**399**	**3**	**31.03**	**79.73**	**10.69**	**16.33**	**(-)5.64**
3	**1133**	**3**	**30.42**	**81.87**	**15.12**	**--------**	**--------**
4	**1546**	**3**	**31.13**	**79.51**	**7.26**	**8.56**	**(-)1.3**
5	8553	1	32.61	77.99	7.28	--------	--------
6	187015	3	30.79	81.57	1.73	--------	--------

7	187016	3	30.76	81.64	23.15	--------	--------
8	187054	3	30.70	81.00	5.71	--------	--------
9	187066	1	32.60	77.68	2.66	--------	--------
10	187070	3	30.60	82.25	2.12	--------	--------
11	187071	3	30.60	82.24	1.83	--------	--------
12	187074	3	30.59	82.21	8.69	--------	--------
13	187076	3	30.59	82.22	2.73	--------	--------
14	**187082**	**2**	**31.43**	**78.25**	**14.45**	**--------**	**--------**
15	1012HWL	3	30.82	81.54	2.80	2.13	(+)0.67
16	1022RS	3	30.92	81.11	2.47	2.39	(+)0.09
17	**138HWL**	**3**	**30.69**	**81.23**	**25441.30**	**25806.38**	**(-)365.08**
18	**142HWL**	**3**	**30.80**	**81.57**	**328.36**	**337.86**	**(-)9.5**
19	**145HWL**	**3**	**30.68**	**81.47**	**41609.90**	**41698.35**	**(-)88.45**
20	**148HWL**	**3**	**30.76**	**81.59**	**135.67**	**123.59**	(+)**12.08**
21	**15002HWL**	**3**	**30.60**	**82.07**	**15.32**	**43.66**	**(-)28.34**
22	**15003HWL**	**3**	**30.59**	**82.08**	**16.71**	**5.3**	(+)**11.41**
23	**150HWL**	**3**	**30.64**	**82.13**	**5997.06**	**5974.58**	(+)**22.48**
24	**159HWL**	**3**	**30.55**	**81.74**	**16.83**	**15.6**	(+)**1.23**
25	205HWL	3	30.79	81.56	6.70	5.56	(+)1.14
26	206HWL	3	30.78	81.55	4.10	6.83	**(-)**2.73
27	**210HWL**	**3**	**30.77**	**81.55**	**65.46**	**60.24**	(+)**5.23**
28	211HWL	3	30.77	81.56	10.79	9.76	(+)1.03
29	**32LWL**	**1**	**32.33**	**78.72**	**115.24**	**109.62**	(+)**5.61**
30	385HWL	3	30.78	81.54	5.00	3.54	(+)1.46
31	**607RS**	**3**	**30.91**	**81.17**	**58.83**	**76.41**	**(-)17.58**
32	**608RS**	**3**	**30.93**	**81.09**	**19.99**	**14.36**	(+)**5.64**
33	608RS	3	30.93	81.10	8.77	4.44	(+)4.33
34	**616RS**	**3**	**30.92**	**81.11**	**13.69**	**11.76**	(+)**1.93**
35	8258HWL	3	30.56	81.71	7.63	7.66	**(-)**0.03
36	8263RS	3	30.92	81.10	2.72	1.74	(+)0.99
37	**8511HWL**	**3**	**30.53**	**81.75**	**15.77**	**13.64**	(+)**2.12**
38	9010HWL	3	30.83	81.53	5.19	8.6	**(-)**3.41
39	9011HWL	3	30.79	81.54	4.58	3.32	(+)1.26
40	9012HWL	3	30.78	81.52	2.30	2.82	**(-)**0.52
41	9049RS	2	31.62	78.02	5.02	5.18	**(-)**0.16
42	9065HWL	3	30.78	81.55	9.31	9.52	**(-)**0.21

6.2: STATUS OF LAKES AS ON MAY 2023

During the month of May 2023, two data products were used for interpretation purpose for the period 29th May 2023 for 98-46 and 98-51 path rows with some gaps in the

Upper Satluj catchment (Fig: 6.2 (a) & Table: 6.2). From the satellite data analysis as the area is under the impact of snow cover and cloud cover and due to partial coverage, a total of 38 lakes could be identified (Fig: 6.2 (c) & Table: 6.2). Out of these 38 lakes, 11 lakes are from Spiti sub basin, 8 from Lower Satluj sub basin and 19 lakes are from Upper Satluj sub basin (Fig: 6.2 (c)). Further out of 38 lakes, 34 lakes are the big one with area more than 10 ha, 1 lake having area between 5-10 ha and 3 lakes are small one with area less than 5 ha. Seven lakes have been identified in river section in Lower Satluj sub basin. The 25 lakes identified in the month of May 2023 when compared with the previous year reflects those 10 lakes have shown decrease in their area where as 15 lakes have shown an increasing trend.

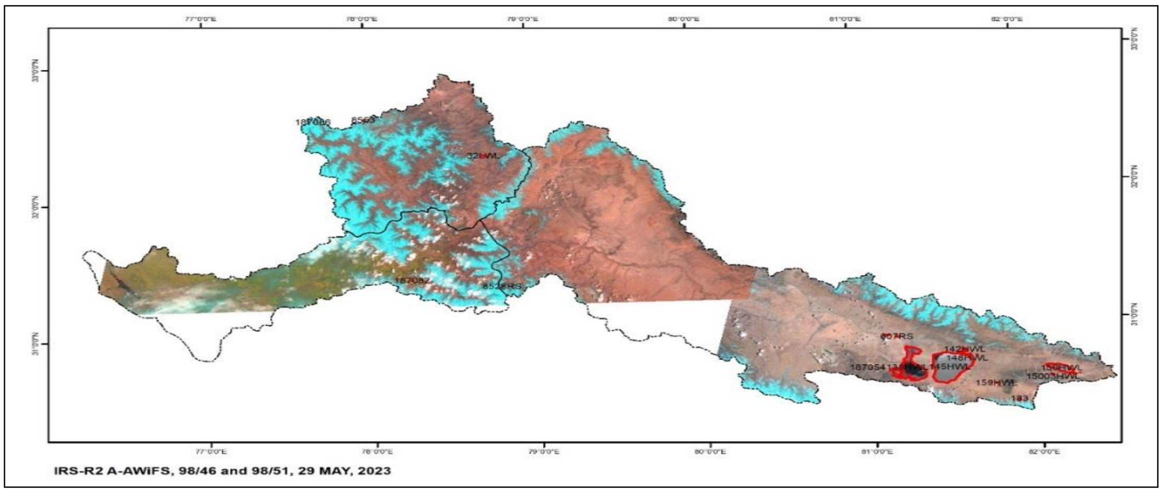


Fig. 6.2 (a): IRS-R2 A-AWiFS, 98/46 and 98/51, 29th May, 2023

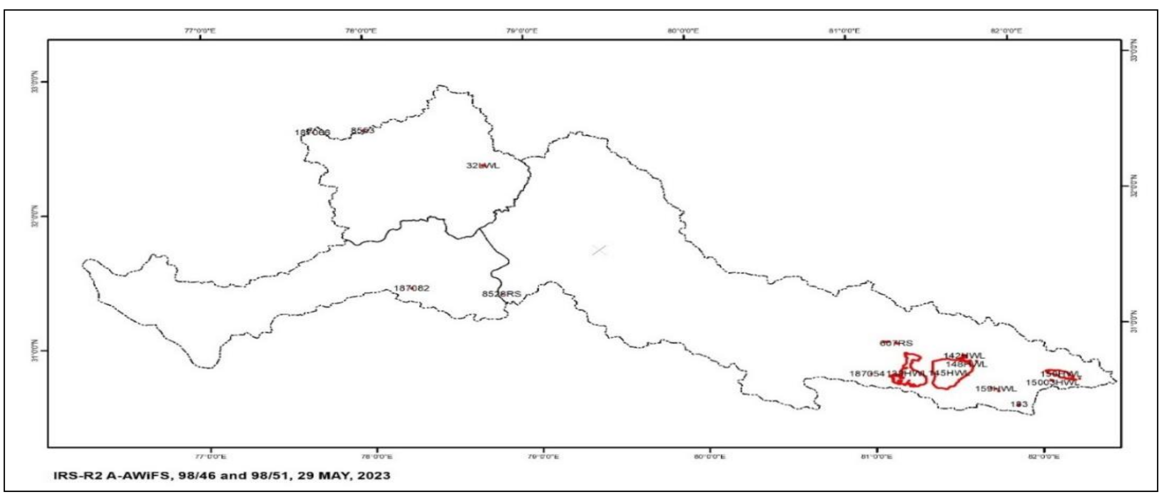


Fig. 6.2 (b): IRS-R2 A-AWiFS, 98/46 and 98/51, 29th May 2023, Interpreted Layer.

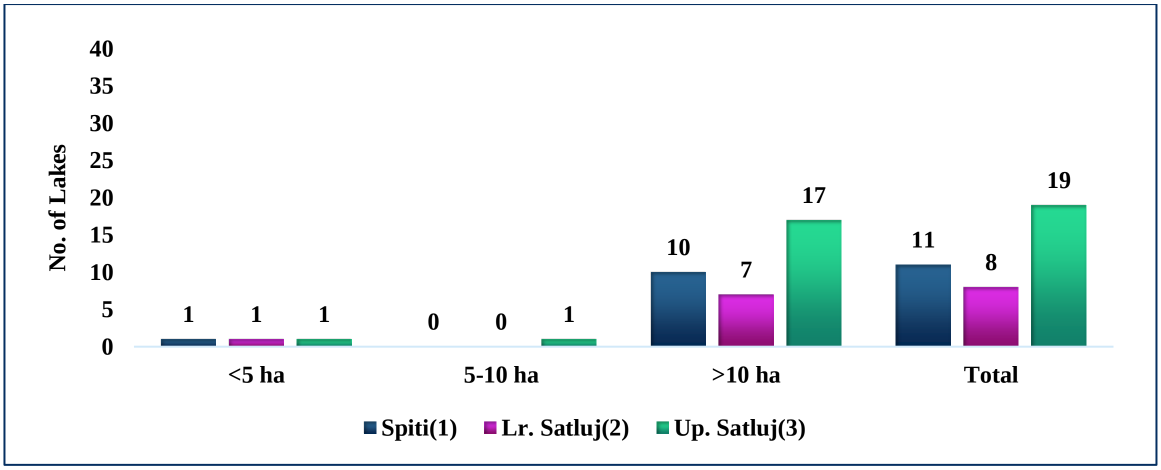


Fig. 6.2 (c): No. lakes based on IRS-R2- A-AWiFS, 98/46 and 98/51, 29th May, 2023

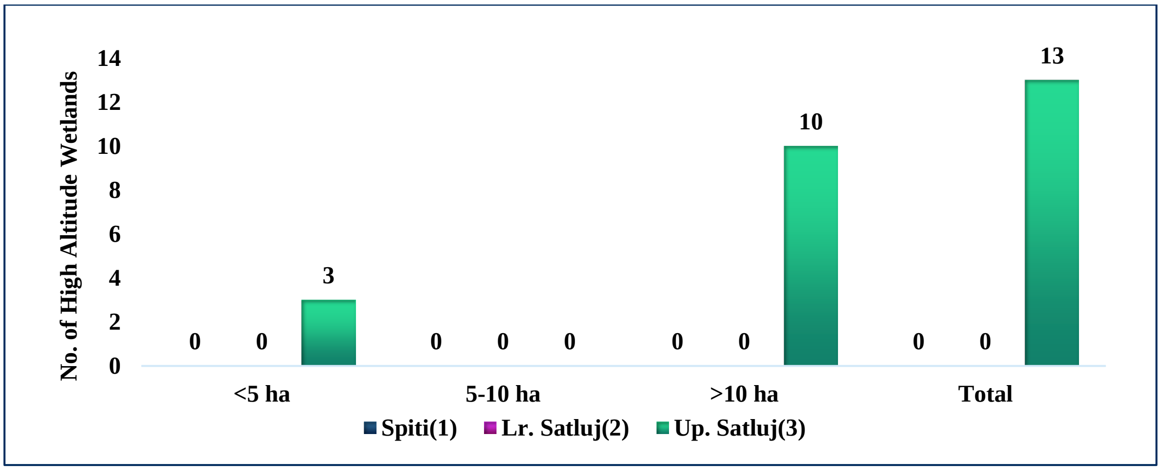


Fig. 6.2 (d): No. of high wetland lakes based on IRS-R2- A-AWiFS, 98/46 and 98/51, 29th May, 2023

Table: 6.2 Aerial extent of lakes as on May, 2023

S. No.	Lake Id.	Basin Number	Latitude	Longitude	Aerial Extent on May 2023 (Ha.)	Aerial Extent on Sept 2022 (Ha.)	Change in Area w.r.t. Sept. 2022 (ha.)
1	**183**	**3**	**30.43**	**81.87**	**24.30**	--------	--------
2	**1133**	**3**	**30.42**	**81.87**	**15.12**	--------	--------
3	8553	1	32.61	77.99	7.28	--------	--------
4	187015	3	30.79	81.57	1.73	--------	--------
5	**187016**	**3**	**30.76**	**81.64**	**23.15**	--------	--------
6	**187054**	**3**	**5.71**	**30.70**	**81.00**	--------	--------
7	187066	1	32.60	77.68	2.66	--------	--------
8	187070	3	30.60	82.25	2.12	--------	--------

9	187071	3	30.60	82.24	1.83	--------	--------
10	187074	3	30.59	82.21	8.69	--------	--------
11	187076	3	30.59	82.22	2.73	--------	--------
12	187054	3	30.70	81.00	5.71	--------	--------
13	187082	2	31.43	14.45	14.45	--------	--------
14	32LWL	1	32.33	78.72	115.24	109.62	(+)5.61
15	138HWL	3	30.69	81.23	25441.30	25806.38	(-)365.08
16	142HWL	3	30.80	81.57	328.36	337.86	(-)9.5
17	145HWL	3	30.68	81.47	41609.90	41698.35	(-)88.45
18	148HWL	3	30.76	81.59	135.67	123.59	(+)12.08
19	159HWL	3	30.55	81.74	16.83	15.6	(+)1.23
20	205HWL	3	30.79	81.56	6.70	5.56	(+)1.14
21	206HWL	3	30.78	81.55	4.10	6.83	(-)2.73
22	210HWL	3	30.77	81.55	65.46	60.24	(+)5.23
23	211HWL	3	30.77	81.56	10.79	9.76	(+)1.03
24	385HWL	3	30.78	81.54	5.00	3.54	(+)1.46
25	607RS	3	30.91	81.17	58.83	76.41	(-)17.58
26	608RS	3	30.93	81.09	19.99	14.36	(+)5.64
27	608RS	3	30.93	81.10	8.77	4.44	(+)4.33
28	616RS	3	30.92	81.11	13.69	11.76	(+)1.93
29	1022RS	3	30.92	81.11	2.47	2.39	(+)0.09
30	8258HWL	3	30.56	81.71	7.63	7.66	(-)0.03
31	8263RS	3	30.92	81.10	2.72	1.74	(+)0.99
32	8528RS	3	31.37	78.80	3.66	13.64	(-)9.98
33	8511HWL	3	30.53	81.75	15.77	8.6	(+)7.17
34	9011HWL	3	30.79	81.54	4.58	3.32	(+)1.26
35	9012HWL	3	30.78	81.52	2.30	2.82	(-)0.52
36	9065HWL	3	30.78	81.55	9.31	9.52	(-)0.21
37	15002HWL	3	30.60	82.07	15.32	43.66	(-)28.34
38	15003HWL	3	30.59	82.08	16.71	5.3	(+)11.41

6.3: STATUS OF LAKES AS ON JUNE 2023

In the month of June 2023, two AWiFS having path rows 97-50A and 97-50B for the period 17th June 2023 were available (Fig: 6.3 (a)) but with partially snow covered. On analysing the satellite data, a total of 59 lakes could be mapped out of which 17 from Spiti sub basin i.e., basin number 1, 4 from Lower Satluj i.e., sub basin number 2 and 38 from the Upper Satluj basin i.e., sub basin number 3 (Fig: 6.3 (b)). Further analysis of the data reflects those 24 lakes are small one with area less than 5 ha, 14 are with areal range 5-

10 ha and 21 lakes are with area greater than10 ha (Fig: 6.3 (c)). Likewise, 59 lakes shows that 10 lakes are the high-altitude wetlands in Upper Satluj basin having 1 wetland as the small with area less than 5 ha, 2 are within the areal range of 5-10 ha and 7 wetlands are having area more than 10 ha (Fig: 6.3 (d)). Comparative analysis shows that 18 lakes has shown a decrease in its area whereas 41 lakes showed an increase in their water spread area w.r.t. 2022 (Table 6.3).

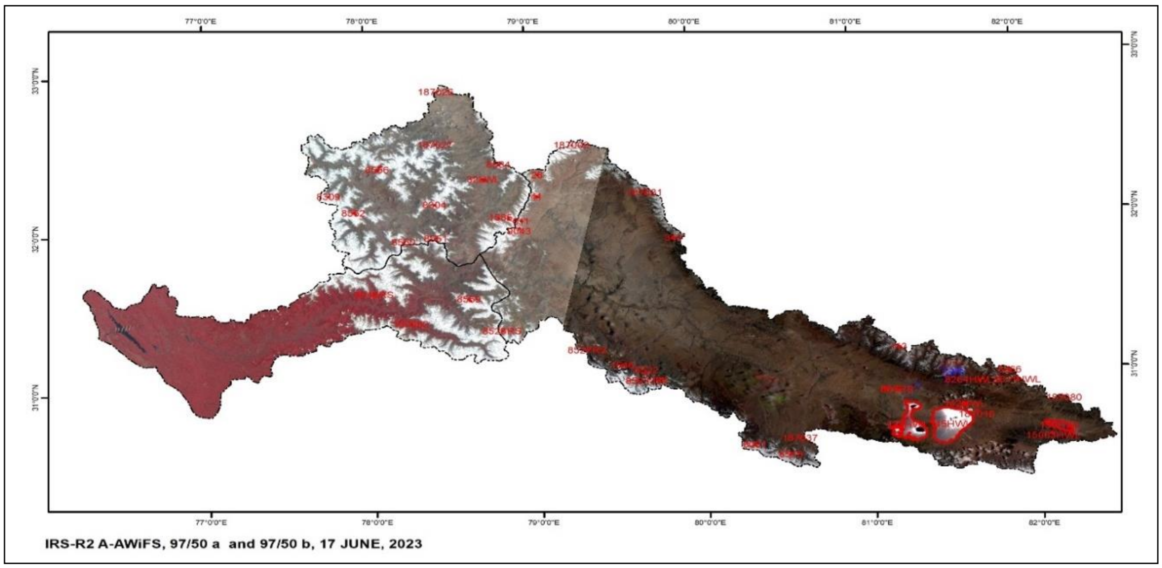


Fig. 6.3 (a): IRS-R2-AWiFS, 97/50 A and 97/50 B, 17th June 2023

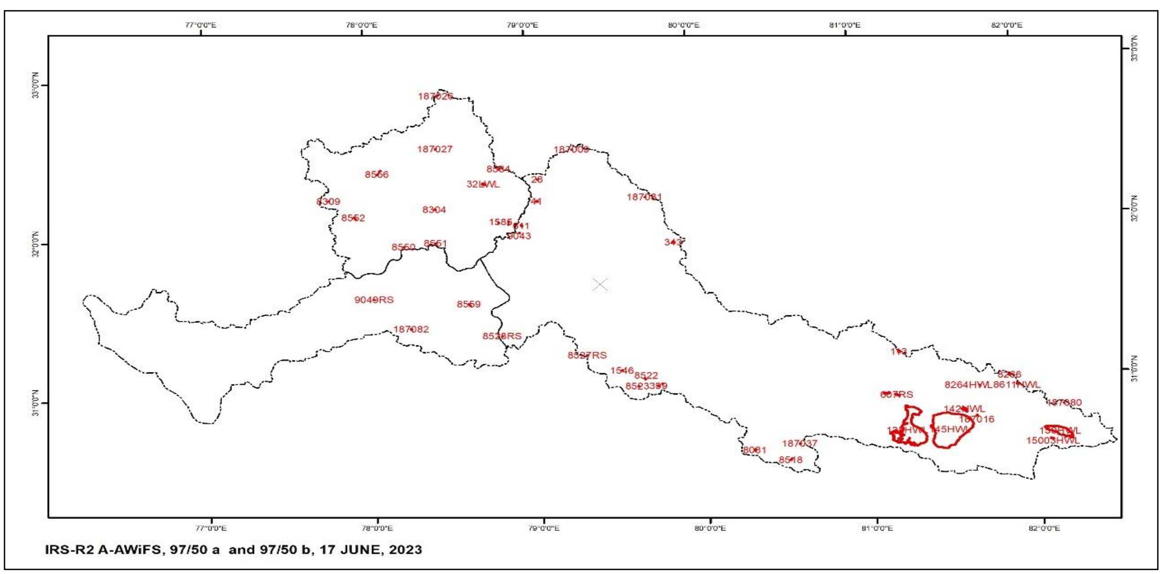


Fig. 6.3 (b): IRS-R2-AWiFS, 97/50 A and 97/50 B, 17th June, 2023, Interpreted Layers

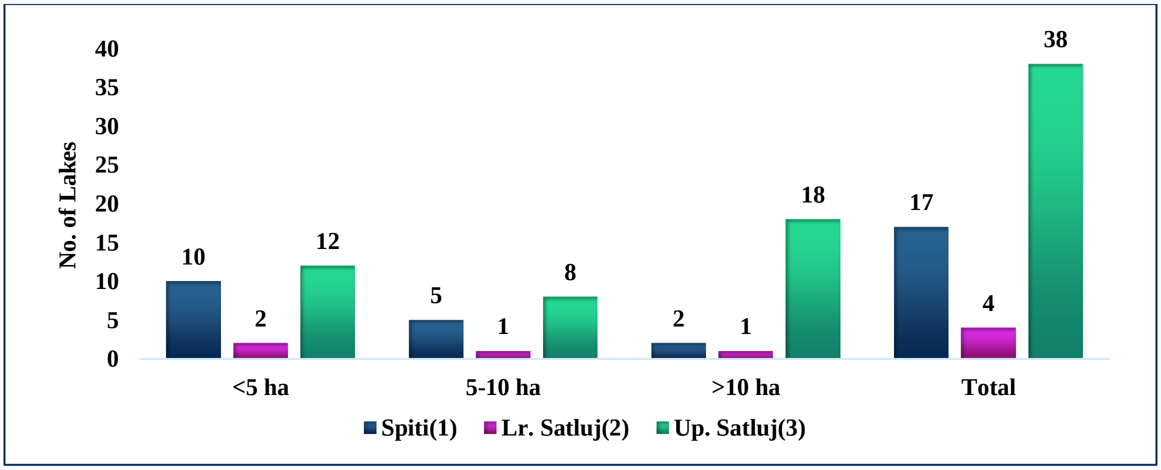


Fig. 6.3 (c): No. of lakes based on IRS-R2-AWiFS, 97/50 A and 97/50 B, 17th June, 2023

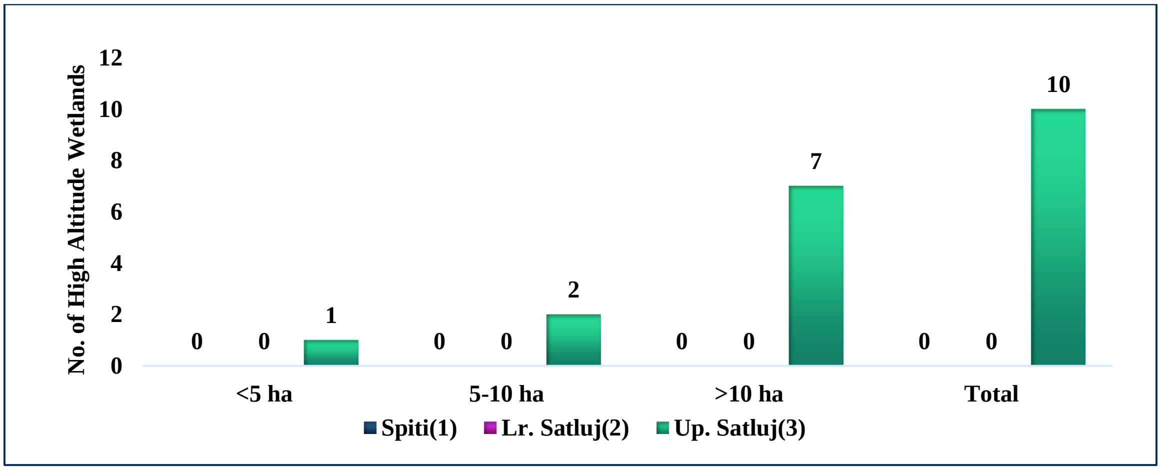


Fig. 6.3 (d): No. of high-altitude wetland lakes-based IRS-R2-AWiFS, 97/50 A and 97/50 B, 17th June, 2023

Table: 6.3 Aerial extent of lakes as on June, 2023

S. No.	Lake Id.	Basin No.	Latitude	Longitude	Aerial Extent on June 2023 (Ha.)	Aerial Extent on Sept 2022 (Ha.)	Change in Area w.r.t. Sept. 2022 (ha.)
1	28	3	32.35	79.05	6.90	7.89	**(-)**0.99
2	**41**	**3**	**32.21**	**79.04**	**27.98**	**31.23**	**(-)3.25**
3	**113**	**3**	**31.18**	**81.19**	**56.57**	**53.61**	(+)**2.95**
4	330	1	32.13	77.92	2.98	3.57	**(-)**0.59
5	**343**	**3**	**31.93**	**79.86**	**37.31**	**36.62**	(+)**0.69**
6	**399**	**3**	**31.03**	**79.73**	**15.98**	**16.33**	**(-)0.35**
7	**611**	**3**	**32.06**	**78.94**	**10.07**	**10.04**	(+)**0.03**

8	1546	3	31.13	79.51	7.26	8.56	**(-)**1.30
9	1585	1	32.09	78.86	2.95	2.94	(+)0.01
10	8024	3	30.54	80.51	2.49	2.76	**(-)**0.27
11	**8031**	**3**	**30.61**	**80.29**	**22.83**	**23.21**	**(-)0.38**
12	8236	3	31.04	79.75	7.75	7.07	(+)0.69
13	**8266**	**3**	**31.01**	**81.85**	**30.64**	**28.57**	(+)**2.07**
14	**8304**	**1**	**32.18**	**78.41**	**11.06**	**10.20**	(+)**0.86**
15	8309	1	32.24	77.76	5.61	4.77	(+)0.84
16	8518	3	30.53	80.50	4.15	3.59	(+)0.56
17	8521	3	31.07	79.65	2.34	2.66	**(-)**0.32
18	8522	3	31.08	79.65	1.88	1.84	(+)0.04
19	8523	3	31.03	79.61	2.88	2.25	(+)0.62
20	8550	1	31.95	78.22	1.33	3.46	**(-)**2.13
21	8551	1	31.97	78.42	8.79	9.97	**(-)**1.18
22	8552	1	32.14	77.91	4.46	4.25	(+)0.21
23	8554	1	32.43	78.09	2.85	3.51	**(-)**0.66
24	8555	1	32.42	78.08	4.96	4.95	(+)0.01
25	8556	1	32.40	78.07	5.52	4.35	(+)1.17
26	8557	1	32.40	78.07	2.35	2.35	(+)0.00
27	8559	2	31.58	78.60	4.84	5.07	**(-)**0.23
28	8560	2	31.56	78.61	4.25	5.73	**(-)**1.48
29	8573	1	32.08	78.80	1.86	1.86	--------
30	8574	1	32.07	78.86	1.29	1.29	--------
31	8584	1	32.42	78.82	8.42	11.73	**(-)**3.31
32	9043	3	32.01	78.93	3.92	3.91	(+)0.01
33	187009	3	32.53	79.27	1.33	--------	--------
34	**187016**	**3**	**30.76**	**81.64**	**23.15**	**--------**	**--------**
35	187026	1	32.89	78.45	8.40	--------	--------
36	187027	1	32.56	78.43	2.53	--------	--------
37	187037	3	30.63	80.56	5.01	--------	--------
38	187080	3	30.81	82.17	2.71	--------	--------
39	187081	3	32.22	79.71	3.15	--------	--------
40	**187082**	**2**	**31.43**	**14.45**	**10.98**	**--------**	**--------**
41	1022RS	3	30.92	81.11	2.47	2.39	(+)0.09
42	**138HWL**	**3**	**30.69**	**81.23**	**25565.60**	**25806.38**	**(-)240.78**
43	**142HWL**	**3**	**30.80**	**81.57**	**357.20**	**337.86**	(+)**19.34**
44	**145HWL**	**3**	**30.68**	**81.47**	**41828.60**	**41698.35**	(+)**130.25**

45	**15002HWI**	**3**	**30.60**	**82.07**	**18.40**	**43.66**	**(-)25.26**
46	**15003HWI**	**3**	**30.59**	**82.08**	**23.00**	**5.30**	(+)**17.70**
47	**150HWL**	**3**	**30.64**	**82.13**	**6067.26**	**5974.58**	(+)**92.68**
48	**32LWL**	**1**	**32.33**	**78.72**	**109.87**	**109.62**	(+)**0.25**
49	**607RS**	**3**	**30.91**	**81.17**	**77.20**	**76.41**	(+)**0.80**
50	**608RS**	**3**	**30.93**	**81.09**	**19.99**	**14.36**	(+)**5.64**
51	608RS	3	30.93	81.10	8.77	4.44	(+)4.33
52	616RS	3	30.92	81.11	13.69	11.76	(+)1.93
53	8264HWL	3	30.95	81.67	4.07	3.09	(+)0.99
54	8515HWL	3	30.70	81.36	72.81	35.98	(+)36.83
55	8527RS	3	31.23	79.31	5.46	4.65	(+)0.81
56	8528RS	3	31.37	78.80	2.58	2.80	**(-)**0.22
57	8610HWL	3	30.95	81.89	6.77	6.66	(+)0.11
58	8611HWL	3	30.95	81.89	7.51	7.19	(+)0.32
59	9049RS	2	31.62	78.02	5.02	5.18	**(-)**0.16

6.4: STATUS OF LAKES AS ON JULY 2023.

During the month of July 2023, no cloud free satellite data could be obtained as a result of which no information could be retrieved during July 2023.

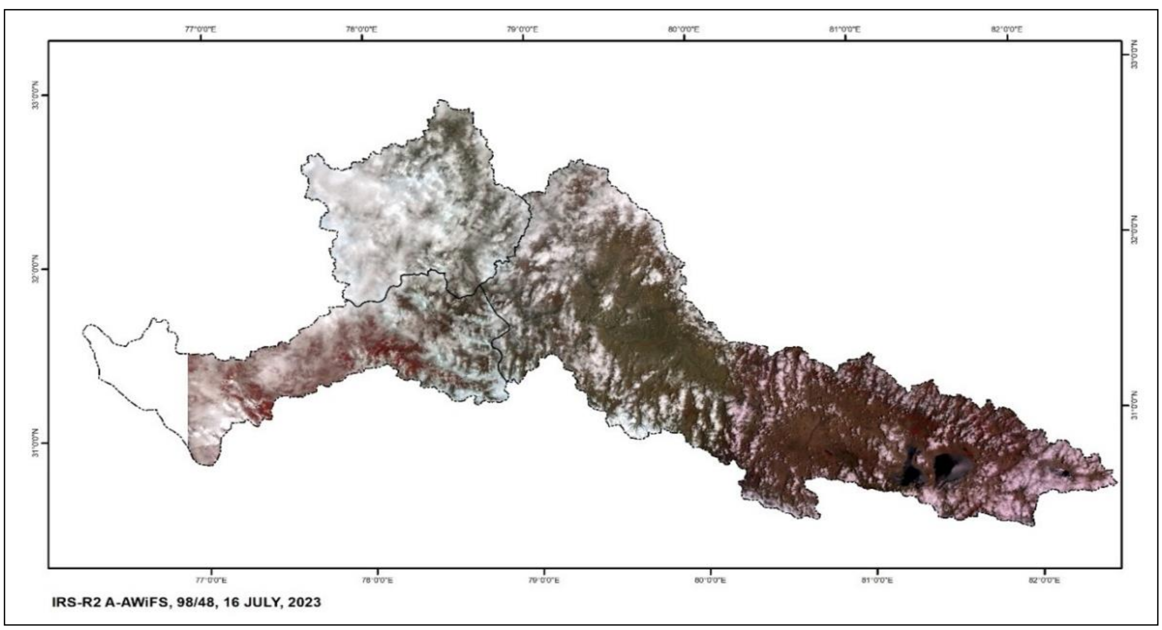


Fig. 7.4 (a): IRS-R2 A-AWiFS, 98/48, 16th July, 2023

6.5: STATUS OF LAKES AS ON AUGUST 2023

From the analysis of the satellite data for the month of August 2023, three data products for 31st August were mosaicked having partial coverage of the Satluj Basin (Fig: 6.5 (a), (b) & (c)). From the analysis of these three products of 16th, 28th and 31st August 2023, a total of 412 lakes in the entire catchment in comparison to 350 lakes (2022) were delineated comprising 55 from Spiti, 58 from Lower Satluj and 299 from Upper Satluj sub basin (Fig: 6.5 (d & e)). On analysing 412 lakes further, it is found that 229 lakes are such which have the area less than 5ha comprising 37 from Spiti, 44 from Lower Satluj and 148 from Upper Satluj basin. Further 103 lakes are such which falls within the areal range of 5-10ha comprising 13 from Spiti, 9 from Lower Satluj and 81 from Upper Satluj basin. Similarly, 80 lakes are such which have the area more than 10ha and are considered big lakes comprising 5 from Spiti, 5 from Lower Satluj and 70 from Upper Satluj basin (Fig. 6.5 (e)). Further, out of 412 lakes, 36 lakes are observed as the high-altitude wetlands comprising 10 wetlands having area less than 5 ha, 11 wetlands between 5-10 ha and 15 wetlands are with area more than10ha and all forming part of the Upper Satluj basin (Fig. 6.5 (f)). On analysing further, when these 412 lakes seen temporally w.r.t. 2022 data, only 355 lakes out of 412 lakes could be compared for their temporal variation and out of which 212 lakes/wetlands have shown an increasing trend in their water spread, whereas 143 lakes/wetlands shown a reducing trend in their water spread with reference to 2022 data (Table: 6.4). The remaining lakes/wetlands which could not be compared form the base line data for their monitoring during the next ablation season, which may be due to the fact that either these lakes /wetlands were either not mapped during 2022 due to snow cover impacts or are the new one and thus mapped this year only. The 12 lakes with ids RS are mainly formed due to the accumulation of water along the main Satluj river course with 11 from the Upper Satluj sub basin and 1from the Lower Satluj sub basin.

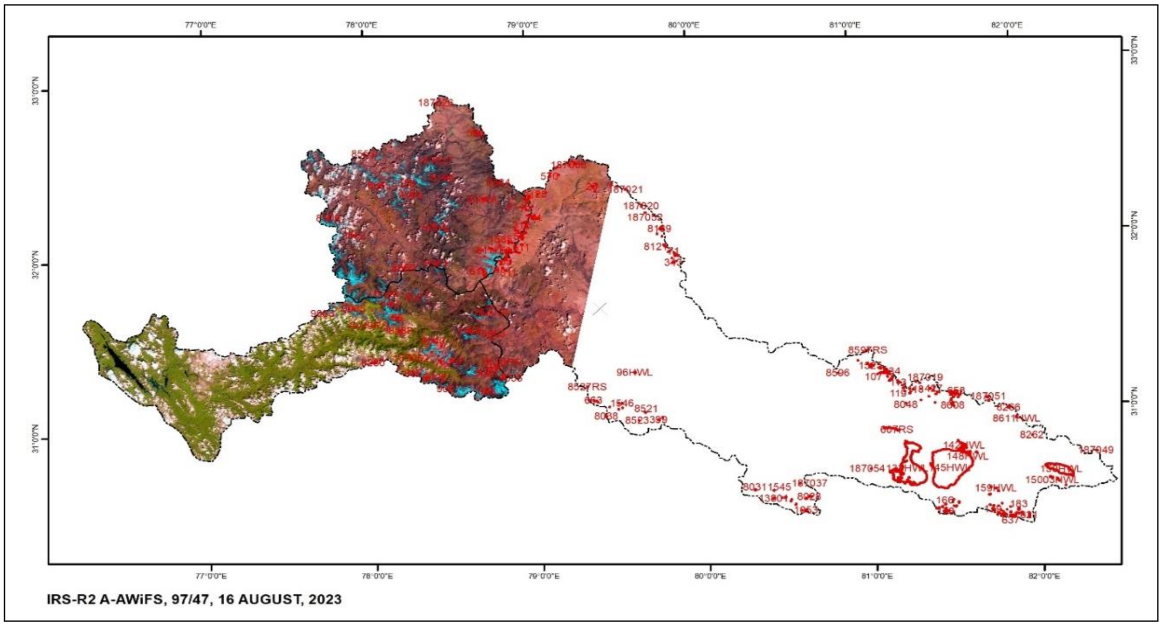


Fig. 6.5 (a): IRS-R2 -AWiFS, 97/47, 16 AUGUST, 2023

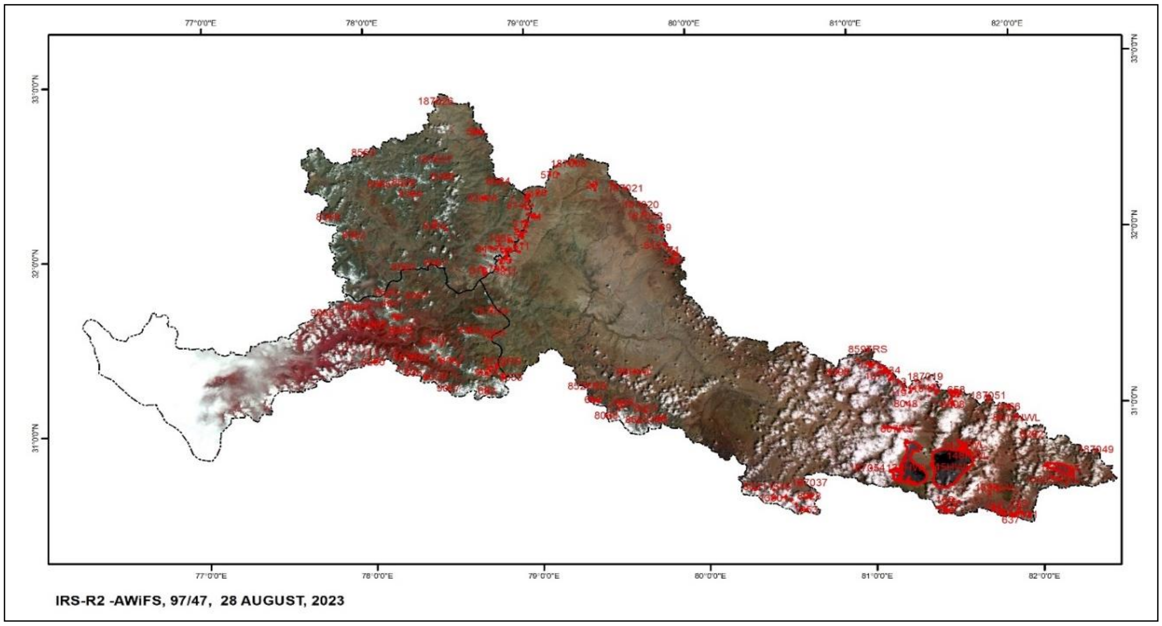


Fig. 6.5 (b): IRS-R2 -AWiFS, 97/47, 28th August, 2023

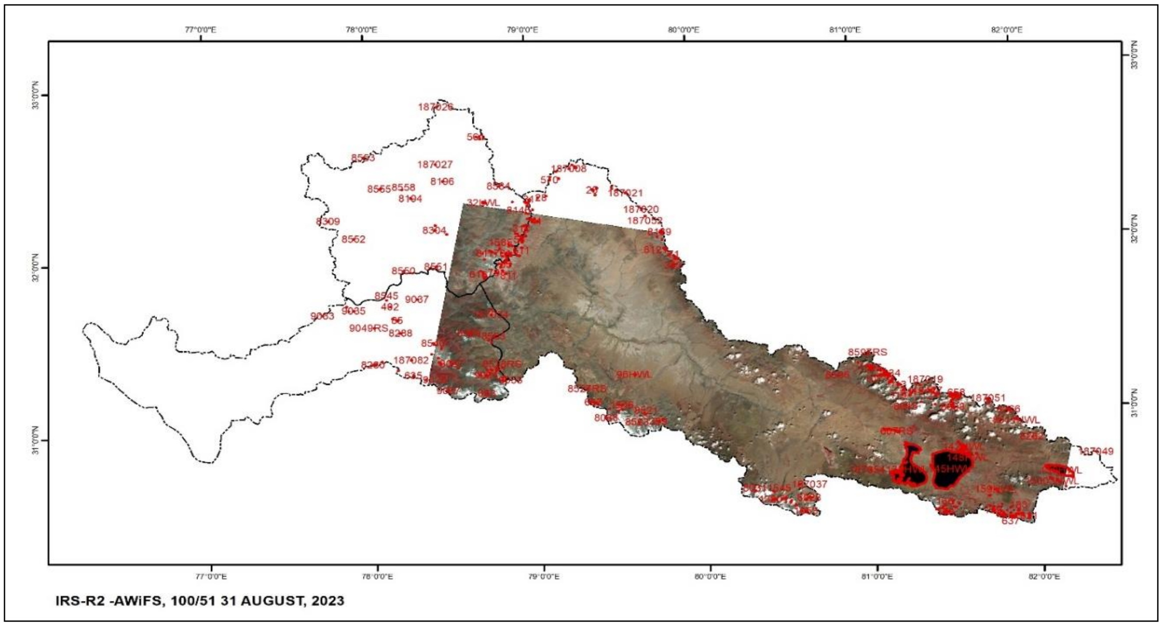


Fig. 6.5 (c): IRS-R2 -AWiFS, 100/51, 31st August, 2023

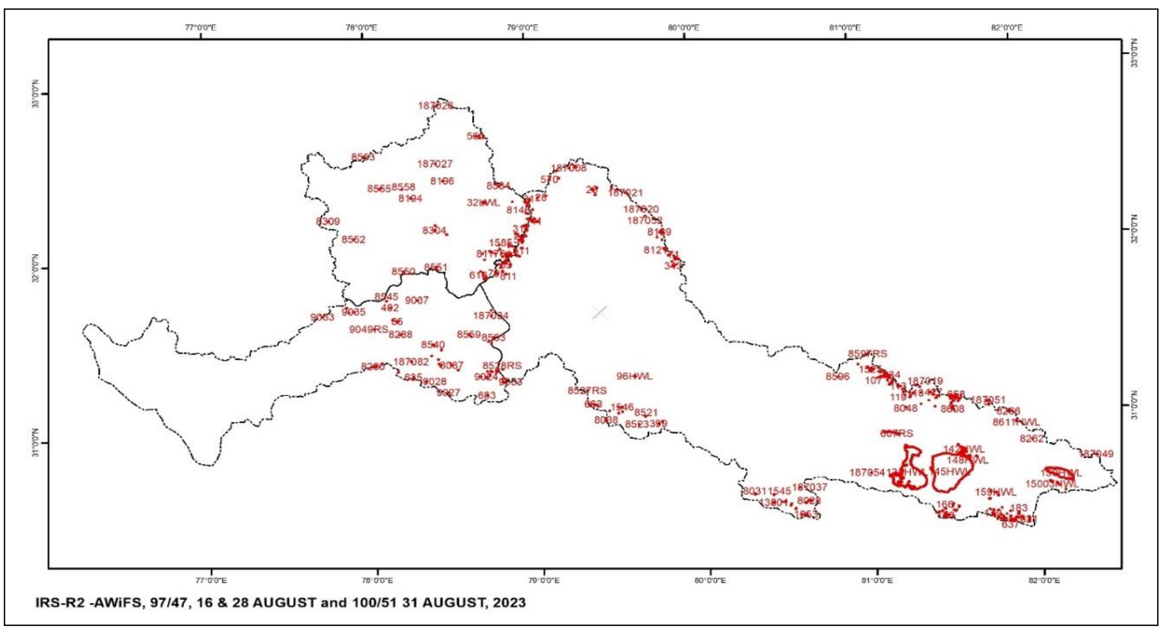


Fig. 6.5 (d): IRS-R2 -AWiFS, 97/47, 16 & 28 Aug and 100/51 31st August, 2023

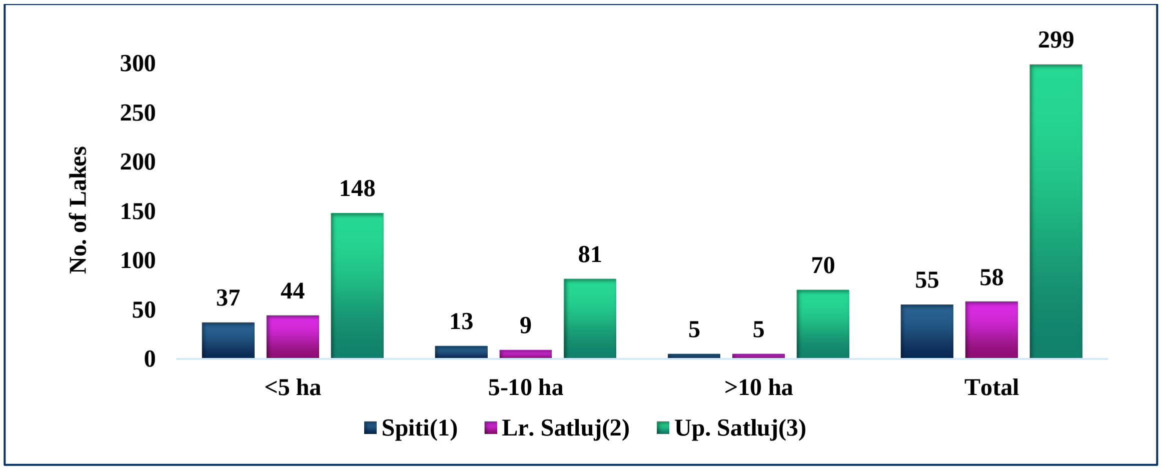


Fig. 6.5 (e): No. of lakes based on IRS-R2, AWiFS, 99/48, 97/47, 16th & 28th August and 100/51, 31st August, 2023

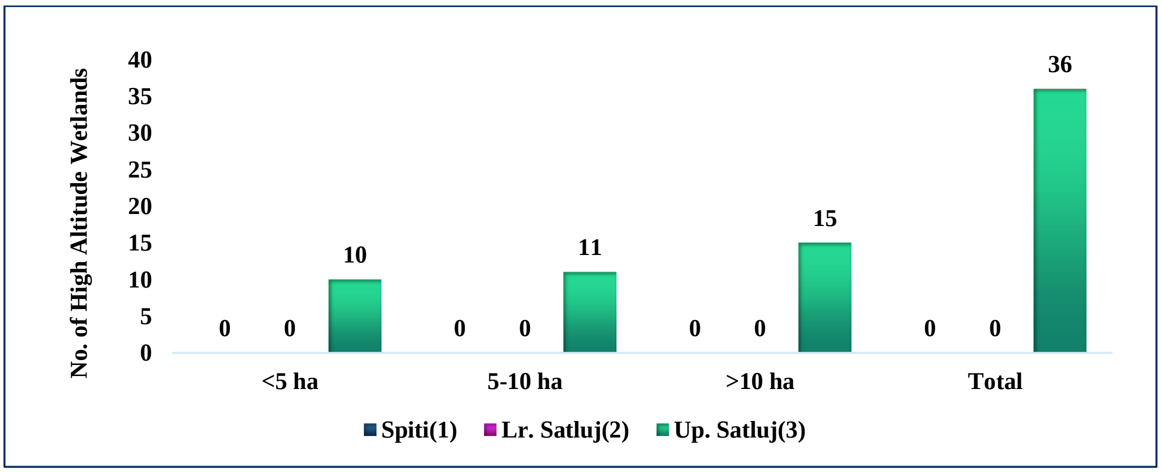


Fig. 6.5 (f): No. of high-altitude wetland lakes based on IRS-R2, AWiFS, 99/48, 97/47, 16 & 28th August and 100/51 31st August, 2023

Table: 6.5 Aerial Extent of lakes as on 99/48, 31st August, 2023

S. No.	Lake Id.	Basin Number	Latitude	Longitude	Aerial Extent on Aug 2023 (Ha.)	Aerial Extent on Sept 2022 (Ha.)	Change in Area w.r.t. Sept. 2022 (ha.)
1	**23**	**3**	**32.39**	**79.42**	**11.51**	**13.65**	**(-)2.13**
2	**25**	**3**	**32.38**	**79.39**	**22.13**	**36.04**	**(-)13.90**
3	28	3	32.35	79.05	7.10	7.89	**(-)**0.79
4	31	3	32.34	79.00	9.04	10.17	**(-)**1.12
5	**39**	**3**	**32.22**	**79.03**	**12.05**	**9.36**	(+)**2.69**
6	**41**	**3**	**32.21**	**79.04**	**33.89**	**31.23**	(+)**2.66**

7	51	3	32.12	78.94	5.53	7.23	**(-)**1.69
8	**54**	**3**	**32.11**	**78.93**	**14.25**	**12.81**	(+)**1.44**
9	**55**	**3**	**32.11**	**78.94**	**13.50**	**12.05**	(+)**1.45**
10	60	3	32.03	78.87	8.38	9.68	**(-)**1.31
11	**61**	**1**	**32.03**	**78.84**	**24.79**	**23.61**	(+)**1.18**
12	**62**	**3**	**32.02**	**78.87**	**12.81**	**13.89**	**(-)1.08**
13	63	3	32.02	78.88	3.91	3.90	(+)0.01
14	**65**	**3**	**31.99**	**78.84**	**24.15**	**33.21**	**(-)9.07**
15	**71**	**3**	**31.98**	**79.87**	**11.58**	**13.20**	**(-)1.62**
16	74	3	31.97	79.88	4.31	5.67	**(-)**1.36
17	**79**	**3**	**31.92**	**78.78**	**21.20**	**23.52**	**(-)2.32**
18	**85**	**2**	**31.66**	**78.17**	**44.09**	**47.64**	**(-)3.56**
19	106	3	31.24	81.10	6.09	6.29	**(-)**0.20
20	107	3	31.24	81.08	6.51	6.56	**(-)**0.05
21	**112**	**3**	**31.20**	**81.15**	**13.97**	**17.43**	**(-)3.46**
22	**113**	**3**	**31.18**	**81.19**	**56.57**	**53.61**	(+)**2.95**
23	**118**	**3**	**31.14**	**81.28**	**19.15**	**19.62**	**(-)0.47**
24	119	3	31.13	81.23	6.07	7.90	**(-)**1.83
25	122	3	31.11	81.43	5.24	4.41	(+)0.84
26	166	3	30.47	81.43	8.56	6.03	(+)2.53
27	**178**	**3**	**30.43**	**81.43**	**229.39**	**229.97**	**(-)0.59**
28	**179**	**3**	**30.43**	**81.71**	**29.56**	**23.75**	(+)**5.81**
29	**183**	**3**	**30.43**	**81.87**	**27.68**	**24.78**	(+)**2.90**
30	**184**	**3**	**30.42**	**81.72**	**23.96**	**14.75**	(+)**9.21**
31	**196**	**3**	**30.39**	**81.89**	**12.24**	**12.86**	**(-)0.62**
32	**312**	**3**	**32.33**	**78.97**	**10.88**	**11.87**	**(-)0.99**
33	**313**	**3**	**32.32**	**78.98**	**10.79**	**12.65**	**(-)1.86**
34	315	1	32.19	78.97	7.31	6.80	(+)0.51
35	**317**	**3**	**32.16**	**78.98**	**12.28**	**11.30**	(+)**0.98**
36	**319**	**3**	**31.98**	**78.84**	**16.97**	**18.56**	**(-)1.59**
37	**343**	**3**	**31.93**	**79.87**	**38.17**	**36.62**	(+)**1.55**
38	**399**	**3**	**31.03**	**79.73**	**15.98**	**16.33**	**(-)0.35**
39	402	2	31.74	78.12	2.95	3.47	**(-)**0.52
40	413	3	32.22	79.01	5.17	4.10	(+)1.07
41	414	1	32.26	78.98	3.42	3.33	(+)0.09
42	415	3	32.33	79.00	3.07	3.04	(+)0.03
43	416	3	32.45	79.19	3.90	4.21	**(-)**0.31
44	422	3	31.23	81.07	4.13	4.10	(+)0.03
45	**423**	**3**	**31.22**	**81.16**	**11.81**	**11.77**	(+)**0.03**
46	426	3	31.09	81.50	7.75	7.67	(+)0.08
47	427	3	31.14	81.38	9.39	9.49	**(-)**0.09
48	431	3	31.11	81.50	9.97	9.54	(+)0.44

49	432	3	31.08	81.52	4.01	3.53	(+)0.48
50	438	3	30.40	81.74	6.64	4.66	(+)1.98
51	439	3	30.43	81.72	5.44	4.61	(+)0.83
52	561	1	32.71	78.69	6.92	7.43	**(-)**0.51
53	562	3	32.28	79.02	4.78	3.37	(+)1.41
54	563	1	32.23	78.98	4.42	3.10	(+)1.33
55	570	3	32.45	79.13	6.47	6.05	(+)0.42
56	592	3	32.12	79.81	4.36	4.59	**(-)**0.23
57	607	3	31.25	81.13	6.86	5.32	(+)1.54
58	**611**	**3**	**32.06**	**78.94**	**10.07**	**10.04**	(+)**0.03**
59	616	1	31.91	78.70	6.26	9.23	**(-)**2.97
60	**621**	**3**	**30.38**	**81.93**	**89.78**	**92.63**	**(-)2.85**
61	622	3	31.27	81.08	3.02	3.30	**(-)**0.28
62	632	3	31.14	79.37	4.43	6.66	**(-)**2.23
63	**634**	**3**	**31.25**	**81.14**	**12.77**	**9.77**	(+)**2.99**
64	**635**	**2**	**31.34**	**78.25**	**15.85**	**25.13**	**(-)9.29**
65	636	3	31.27	81.11	5.08	4.39	(+)0.69
66	**637**	**3**	**30.39**	**81.84**	**17.27**	**10.62**	(+)**6.65**
67	638	3	30.39	81.84	3.06	1.97	(+)1.08
68	638	3	30.38	81.83	3.87	2.53	(+)1.33
69	645	3	31.27	81.09	7.41	8.05	**(-)**0.65
70	646	3	31.26	81.12	4.31	1.72	(+)2.59
71	647	3	31.26	81.12	5.97	3.64	(+)2.32
72	648	3	31.24	81.12	5.43	4.19	(+)1.24
73	649	3	31.24	81.13	4.31	2.49	(+)1.83
74	651	3	31.13	81.40	6.66	7.97	**(-)**1.31
75	655	3	31.10	81.51	7.77	7.22	(+)0.55
76	656	3	31.10	81.53	5.07	3.19	(+)1.88
77	657	3	31.10	81.54	6.71	5.84	(+)0.87
78	**658**	**3**	**31.12**	**81.54**	**12.10**	**11.17**	(+)**0.93**
79	663	3	31.15	79.34	6.90	6.14	(+)0.76
80	**683**	**2**	**31.22**	**78.70**	**14.21**	**13.27**	(+)**0.94**
81	**688**	**3**	**30.41**	**81.82**	**10.81**	**10.39**	(+)**0.42**
82	**811**	**3**	**31.91**	**78.84**	**13.12**	**13.90**	**(-)0.78**
83	825	3	31.25	81.11	3.38	2.01	(+)1.37
84	**827**	**3**	**31.19**	**81.14**	**8.13**	**10.60**	**(-)2.46**
85	828	3	31.21	81.15	2.69	2.00	(+)0.69
86	840	3	30.40	81.79	6.12	3.69	(+)2.43
87	865	3	30.40	81.77	3.73	3.63	(+)0.09
88	870	1	32.13	78.93	2.37	1.37	(+)1.00
89	885	3	31.93	79.88	2.46	2.45	(+)0.01
90	888	3	31.20	81.15	1.70	1.72	**(-)**0.02

91	895	3	30.38	81.84	2.70	2.47	(+)0.23
92	1038	3	32.13	79.80	5.58	4.97	(+)0.61
93	**1053**	**3**	**30.48**	**80.59**	**24.67**	**19.94**	(+)**4.72**
94	**1133**	**3**	**30.42**	**81.87**	**16.33**	**14.31**	(+)**2.03**
95	1142	3	30.40	81.77	1.36	2.74	**(-)**1.38
96	1149	3	30.40	81.77	8.55	7.15	(+)1.40
97	1155	3	31.99	79.84	2.48	3.52	**(-)**1.04
98	1510	3	31.09	81.56	3.77	2.28	(+)1.49
99	1515	3	31.10	81.42	4.10	5.27	**(-)**1.16
100	1516	3	31.15	81.41	2.67	2.74	**(-)**0.07
101	1519	3	31.16	81.21	3.39	2.40	(+)0.99
102	1524	3	31.29	81.03	7.82	5.98	(+)1.84
103	**1525**	**3**	**31.28**	**81.03**	**20.78**	**24.34**	**(-)3.56**
104	**1531**	**3**	**31.97**	**78.87**	**12.28**	**12.44**	**(-)0.15**
105	1532	3	31.96	78.87	5.61	4.28	(+)1.33
106	1543	3	30.45	81.39	4.83	3.77	(+)1.06
107	1545	3	30.60	80.40	6.03	7.97	**(-)**1.94
108	1546	3	31.13	79.51	7.26	8.56	**(-)**1.30
109	1552	1	32.25	78.99	2.12	1.42	(+)0.70
110	1568	3	32.01	78.84	2.73	2.72	(+)0.01
111	1585	1	32.09	78.86	2.95	2.94	(+)0.01
112	1606	3	32.22	79.00	4.73	1.68	(+)3.05
113	6021	3	31.12	81.26	3.29	1.35	(+)1.94
114	6060	3	31.93	78.82	1.75	1.75	(+)0.00
115	6088	3	31.05	81.51	3.40	3.37	(+)0.03
116	7004	3	31.93	78.82	2.55	2.54	(+)0.01
117	8005	3	30.38	81.83	1.11	1.10	(+)0.01
118	8008	3	30.40	81.78	0.90	1.51	**(-)**0.60
119	8011	3	30.48	80.57	6.27	5.64	(+)0.63
120	8024	3	30.54	80.51	2.49	2.76	**(-)**0.27
121	**8027**	**3**	**30.55**	**80.47**	**16.39**	**15.60**	(+)**0.79**
122	8028 (1)	3	32.17	78.97	3.20	2.60	(+)0.60
123	8028 (2)	3	30.55	80.62	8.36	8.31	(+)0.05
124	8029	3	30.55	80.63	3.98	3.95	(+)0.03
125	**8031**	**3**	**30.61**	**80.29**	**22.83**	**23.21**	**(-)0.38**
126	8037	3	31.06	79.41	6.68	6.65	(+)0.03
127	8038	3	31.06	79.41	7.87	7.84	(+)0.03
128	8047	3	31.13	79.49	2.69	4.16	**(-)**1.47
129	8048	3	31.06	81.23	7.13	6.79	(+)0.34
130	8052	3	31.08	81.55	4.49	4.03	(+)0.46
131	8053	3	31.09	81.55	1.38	2.63	**(-)**1.25
132	8054	3	31.09	81.53	3.60	3.68	**(-)**0.08

133	8056	3	31.10	81.41	1.95	2.58	**(-)**0.62
134	8057	3	31.12	81.26	6.01	5.27	(+)0.74
135	8058	3	31.11	81.42	2.05	2.03	(+)0.02
136	8063	3	31.14	81.26	2.03	2.84	**(-)**0.81
137	**8065**	**3**	**31.15**	**81.22**	**13.96**	**14.08**	**(-)0.12**
138	8071	2	31.29	78.80	2.86	2.71	(+)0.15
139	8074	3	31.22	81.13	4.20	5.77	**(-)**1.57
140	8076	3	31.23	81.14	2.74	1.15	(+)1.59
141	8077	2	31.33	78.70	4.27	4.91	**(-)**0.64
142	**8079**	**3**	**31.23**	**81.14**	**13.42**	**12.54**	(+)**0.88**
143	8083	3	31.28	81.03	2.33	2.43	**(-)**0.10
144	8086	3	31.30	81.01	4.09	4.82	**(-)**0.73
145	8087	2	31.40	78.49	5.21	7.96	**(-)**2.75
146	8088	3	31.32	80.95	2.70	2.98	**(-)**0.28
147	8096	1	31.93	78.70	1.68	1.68	(+)0.00
148	8101	1	31.93	78.68	1.44	1.33	(+)0.11
149	8107	3	31.96	79.90	6.90	2.19	(+)4.72
150	8117	1	32.04	78.76	2.33	2.71	**(-)**0.38
151	8118	1	32.04	78.76	1.36	1.83	**(-)**0.47
152	8121	3	32.02	79.83	5.86	13.96	**(-)**8.10
153	8123	3	32.07	78.88	3.00	2.99	(+)0.01
154	8125	3	32.03	79.81	5.77	2.62	(+)3.16
155	**8127**	**1**	**32.06**	**78.81**	**11.10**	**11.07**	(+)**0.03**
156	8131	3	32.12	78.95	4.25	4.20	(+)0.05
157	8137	1	32.14	78.92	5.51	4.43	(+)1.08
158	8138	3	32.15	78.96	4.15	3.14	(+)1.01
159	8139	3	32.12	79.79	8.51	8.10	(+)0.42
160	8141	1	32.19	78.96	3.93	2.96	(+)0.97
161	8142	3	32.21	79.02	3.71	3.77	**(-)**0.05
162	8143	3	32.21	79.01	4.23	2.05	(+)2.17
163	**8146**	**3**	**32.30**	**78.98**	**15.33**	**18.62**	**(-)3.29**
164	8153	3	32.35	79.10	4.51	3.68	(+)0.82
165	8154	3	32.35	79.41	5.50	2.75	(+)2.75
166	8159	3	32.39	79.51	2.60	1.18	(+)1.42
167	8170	2	31.40	78.42	2.69	3.16	**(-)**0.47
168	8171	2	31.41	78.41	1.65	2.69	**(-)**1.04
169	8172	2	31.44	78.41	2.35	3.00	**(-)**0.65
170	8173	2	31.46	78.37	2.65	3.43	**(-)**0.78
171	**8194**	**1**	**32.36**	**78.27**	**12.36**	**13.97**	**(-)1.61**
172	8196	1	32.46	78.47	8.34	6.60	(+)1.74
173	8236	3	31.04	79.75	7.75	7.07	(+)0.69
174	**8249**	**3**	**30.40**	**81.85**	**22.18**	**25.98**	**(-)3.81**

175	8251	3	30.40	81.88	9.02	4.80	(+)4.22
176	8252	3	30.47	81.43	1.63	1.92	**(-)**0.28
177	8262	3	30.84	81.98	4.87	4.15	(+)0.72
178	8265	3	31.10	79.49	4.07	4.06	(+)0.02
179	**8266**	**3**	**31.01**	**81.85**	**30.64**	**28.57**	(+)**2.07**
180	8277	2	31.42	78.07	1.96	3.01	**(-)**1.05
181	8280	2	31.41	78.01	7.52	10.30	**(-)**2.79
182	8281	2	31.41	78.03	0.67	5.35	**(-)**4.68
183	8281	2	31.41	78.03	5.62	6.53	**(-)**0.91
184	8286	3	32.04	78.90	2.69	2.68	(+)0.01
185	8287	2	31.59	78.18	1.39	1.94	**(-)**0.55
186	8288	2	31.59	78.18	8.71	10.46	**(-)**1.76
187	8293	3	31.95	79.86	1.68	1.77	**(-)**0.09
188	8295	1	32.04	78.70	2.41	2.40	(+)0.01
189	8296	3	32.02	79.82	2.39	4.86	**(-)**2.47
190	8299	3	32.12	78.95	3.64	1.84	(+)1.81
191	**8304**	**1**	**32.18**	**78.41**	**14.09**	**10.20**	(+)**3.89**
192	8307	1	32.20	78.42	6.67	5.68	(+)0.98
193	8309	1	32.24	77.76	4.47	4.77	**(-)**0.30
194	8506	3	30.39	81.78	1.79	1.78	(+)0.01
195	8507	3	30.40	81.77	1.21	1.16	(+)0.05
196	8508	3	30.40	81.77	2.17	2.09	(+)0.08
197	8509	3	30.40	81.76	1.19	1.18	(+)0.01
198	8514	3	30.46	81.41	3.24	2.76	(+)0.48
199	**8517**	**3**	**30.51**	**80.53**	**12.30**	**11.76**	(+)**0.54**
200	8518	3	30.53	80.50	4.15	3.59	(+)0.56
201	8520	3	31.07	79.65	2.00	2.00	**(-)**0.01
202	8521	3	31.07	79.65	2.34	2.66	**(-)**0.32
203	8522	3	31.08	79.65	1.88	1.84	(+)0.04
204	8523	3	31.11	79.44	2.26	2.25	(+)0.01
205	8523	3	31.03	79.61	2.88	2.96	**(-)**0.09
206	8524	3	31.15	79.36	2.35	2.82	**(-)**0.48
207	8525	3	31.16	79.32	1.26	1.25	(+)0.00
208	8529	2	31.32	78.80	0.85	0.85	(+)0.00
209	8530	2	31.31	78.79	1.00	0.94	(+)0.06
210	8531	2	31.36	78.72	2.77	4.59	**(-)**1.82
211	8532	2	31.36	78.70	2.71	2.45	(+)0.27
212	8537	2	31.49	78.43	1.94	1.87	(+)0.07
213	8538	2	31.49	78.43	2.98	4.84	**(-)**1.85
214	8539	2	31.52	78.38	5.00	5.17	**(-)**0.17
215	8540	2	31.52	78.38	8.92	9.86	**(-)**0.94
216	8541	2	31.37	78.16	4.75	2.89	(+)1.86

217	8543	2	31.67	78.14	4.37	4.00	(+)0.37
218	8545	2	31.78	78.10	1.31	3.56	**(-)**2.25
219	8546	2	31.78	78.10	2.32	4.04	**(-)**1.73
220	8550	1	31.95	78.22	1.33	3.46	**(-)**2.13
221	8551	1	31.97	78.42	8.79	9.97	**(-)**1.18
222	8552	1	32.14	77.91	4.28	4.25	(+)0.03
223	8553	1	32.61	77.99	7.28	5.77	(+)1.50
224	8554	1	32.43	78.09	2.85	3.51	**(-)**0.66
225	8555	1	32.42	78.08	4.96	4.95	(+)0.01
226	8558	1	32.42	78.22	4.41	3.46	(+)0.94
227	8559	2	31.58	78.60	4.84	5.07	**(-)**0.23
228	8560	2	31.56	78.61	4.25	5.73	**(-)**1.48
229	8561	2	31.53	78.72	3.58	3.57	(+)0.01
230	8562	2	31.52	78.73	4.12	6.74	**(-)**2.63
231	8563	2	31.55	78.75	7.73	5.58	(+)2.15
232	8565	1	32.00	78.71	1.86	1.86	(+)0.00
233	8566	3	31.93	78.82	1.14	1.14	(+)0.00
234	8567	3	31.96	78.81	6.13	6.11	(+)0.02
235	8568	3	31.97	78.80	1.33	1.37	**(-)**0.04
236	8569	3	31.99	78.85	1.62	2.16	**(-)**0.54
237	8570	1	32.01	78.82	2.42	2.42	(+)0.01
238	8571	1	32.03	78.78	1.46	1.45	(+)0.00
239	8573	1	32.08	78.80	1.34	1.86	**(-)**0.52
240	8574	1	32.07	78.86	1.29	1.29	(+)0.00
241	8575	3	32.02	78.91	8.74	2.38	(+)6.36
242	8576	3	32.12	78.95	2.15	2.45	**(-)**0.29
243	8577	1	32.14	78.91	1.34	1.91	**(-)**0.57
244	8580	3	32.32	78.99	3.78	4.40	**(-)**0.61
245	8581	1	32.33	78.90	2.31	3.24	**(-)**0.94
246	8584	1	32.42	78.82	8.42	11.73	**(-)**3.31
247	8588	3	32.38	79.51	0.66	2.85	**(-)**2.19
248	8590	3	32.13	79.80	4.98	4.96	(+)0.02
249	8596	3	31.25	80.83	6.15	6.37	**(-)**0.22
250	8598	3	31.28	81.02	1.68	1.49	(+)0.19
251	8599	3	31.29	81.05	3.49	2.34	(+)1.15
252	8600	3	31.24	81.11	2.18	2.42	**(-)**0.24
253	8602	3	31.09	81.37	2.99	2.97	(+)0.02
254	8603	3	31.06	81.41	3.93	3.89	(+)0.03
255	8607	3	31.03	81.52	1.71	1.82	**(-)**0.11
256	8608	3	31.04	81.51	5.05	4.97	(+)0.09
257	8609	3	31.09	81.55	2.08	2.51	**(-)**0.43
258	8614	3	31.10	79.51	1.44	1.77	**(-)**0.33

259	8616	2	31.71	78.74	2.98	4.14	**(-)**1.15
260	8654	2	31.72	77.87	4.57	4.35	(+)0.23
261	9000	3	31.27	81.08	1.53	1.39	(+)0.14
262	9001	3	31.24	81.09	2.03	2.62	**(-)**0.59
263	9003	3	31.07	81.32	2.99	4.93	**(-)**1.94
264	9004	3	31.07	81.50	1.89	1.83	(+)0.06
265	9005	3	31.06	81.50	1.52	1.11	(+)0.41
266	9006	3	31.11	81.52	3.76	3.85	**(-)**0.09
267	9007	3	31.12	81.54	5.86	4.05	(+)1.81
268	9008	3	31.04	81.51	4.04	4.01	(+)0.04
269	9009	3	31.04	81.51	3.27	3.24	(+)0.03
270	9015	3	30.45	81.38	8.31	8.24	(+)0.07
271	9016	3	30.46	81.41	1.72	4.04	**(-)**2.32
272	9017	3	30.55	80.45	3.90	4.37	**(-)**0.47
273	9018	2	31.36	78.77	2.70	3.47	**(-)**0.78
274	9019	2	31.36	78.76	1.26	1.23	(+)0.03
275	9020	2	31.35	78.76	2.25	5.48	**(-)**3.23
276	9021	2	31.36	78.73	4.37	4.03	(+)0.34
277	9022	2	31.34	78.72	4.45	4.31	(+)0.14
278	9024	2	31.33	78.70	4.61	4.60	(+)0.01
279	9025	2	31.33	78.66	2.69	3.02	**(-)**0.33
280	9027	2	31.25	78.46	4.73	10.79	**(-)**6.05
281	**9028**	**2**	**31.31**	**78.33**	**15.72**	**13.63**	(+)**2.08**
282	9029	2	31.42	78.07	2.67	3.85	**(-)**1.18
283	9030	2	31.37	78.53	2.55	2.54	(+)0.00
284	9031	2	31.41	78.48	3.00	3.93	**(-)**0.93
285	9032	2	31.40	78.42	3.69	5.26	**(-)**1.57
286	9033	2	31.70	77.71	4.87	5.96	**(-)**1.09
287	9034	2	31.75	77.86	3.28	3.27	(+)0.00
288	9035	2	31.72	77.90	8.35	7.54	0.80
289	9037	2	31.78	78.29	2.20	3.88	**(-)**1.69
290	9043	3	32.01	78.93	3.92	3.91	(+)0.01
291	9044	1	32.03	78.82	5.31	5.29	(+)0.01
292	9045	1	32.01	78.85	1.98	1.98	(+)0.01
293	9046	3	31.95	78.81	2.98	1.68	(+)1.30
294	9049	1	31.90	78.72	1.32	0.74	(+)0.57
295	9050	1	31.89	78.70	2.16	2.16	---------
296	9052	2	31.33	78.70	2.71	4.63	**(-)**1.92
297	9053	2	31.30	78.80	3.76	4.49	**(-)**0.74
298	9056	3	31.15	81.22	4.03	3.40	(+)0.63
299	9058	3	31.97	79.88	6.26	8.48	**(-)**2.22
300	9060	3	31.96	79.88	4.60	4.15	(+)0.45

301	9062	3	31.99	79.84	5.66	6.17	**(-)**0.51
302	**13801**	**3**	**30.55**	**80.40**	**41.84**	**44.02**	**(-)2.18**
303	18701	3	30.39	81.85	4.93	4.01	(+)0.91
304	**185001**	**3**	**30.41**	**81.75**	**11.31**	**11.50**	**(-)0.19**
305	187004	3	30.40	81.78	7.42	--------	--------
306	187005	3	32.37	79.53	2.45	--------	--------
307	187006	1	32.46	79.13	3.81	--------	--------
308	187007	3	32.49	79.17	3.20	--------	--------
309	187008	3	32.51	79.25	7.73	--------	--------
310	187009	3	32.53	79.27	2.64	--------	--------
311	187010	3	32.51	79.29	3.44	--------	--------
312	187011	3	32.08	79.80	6.60	--------	--------
313	187012	1	32.03	78.86	8.87	--------	--------
314	187013	3	31.24	81.11	17.35	--------	--------
315	187014	3	30.92	81.14	4.71	--------	--------
316	187015	3	30.79	81.57	1.73	--------	--------
317	187016	3	30.76	81.64	23.15	--------	--------
318	187017	3	30.40	81.87	9.71	--------	--------
319	187018	3	31.17	81.32	1.47	--------	--------
320	187019	3	31.18	81.30	3.98	--------	--------
321	187020	3	32.26	79.68	7.55	--------	--------
322	187021	3	32.35	79.60	8.63	--------	--------
323	187022	3	32.35	79.59	5.79	--------	--------
324	187023	1	32.70	78.71	2.58	--------	--------
325	187024	1	32.70	78.73	2.08	--------	--------
326	187025	1	32.71	78.71	4.11	--------	--------
327	187026	1	32.89	78.45	8.40	--------	--------
328	187027	1	32.56	78.43	2.53	--------	--------
329	187028	1	32.15	78.49	7.21	--------	--------
330	187029	1	32.05	78.74	1.21	--------	--------
331	187030	1	32.04	78.75	1.11	--------	--------
332	187031	1	32.04	78.76	2.24	--------	--------
333	187032	1	31.90	78.71	1.38	--------	--------
334	187033	1	31.90	78.70	1.39	--------	
335	187034	2	31.68	78.74	7.34	--------	--------
336	187035	3	32.12	78.95	8.49	--------	--------
337	187036	3	30.55	80.60	10.95	--------	--------
338	187037	3	30.63	80.56	5.01	--------	--------
339	187038	3	30.45	81.43	7.39	--------	--------
340	187039	3	30.43	81.47	1.60	--------	--------
341	187040	3	30.43	81.48	1.75	--------	--------
342	187041	3	30.46	81.50	2.26	--------	--------

343	187042	3	30.46	81.48	2.42	--------	--------
344	187043	3	30.45	81.49	1.84	--------	--------
345	187044	3	30.48	81.47	2.25	--------	--------
346	187045	3	30.49	81.48	2.34	--------	--------
347	187046	3	30.48	81.51	4.25	--------	--------
348	187047	3	30.48	81.51	10.92	--------	--------
349	187048	3	30.50	81.48	2.71	--------	--------
350	187049	3	30.73	82.36	2.69	--------	--------
351	187050	3	31.07	81.72	8.65	--------	--------
352	187051	3	31.05	81.73	20.36	--------	--------
353	187052	3	32.22	79.71	3.15	--------	
354	187053	3	32.09	78.95	8.85	--------	--------
355	187054	3	30.70	81.00	5.71	--------	--------
356	187055	3	32.13	78.97	4.84	--------	--------
357	187056	3	31.14	81.33	1.88	--------	--------
358	187057	3	32.51	79.30	1.19	--------	--------
359	187058	3	32.52	79.29	1.36	--------	
360	187059	3	30.39	81.82	21.53	--------	--------
361	187060	3	30.42	81.80	2.23	--------	--------
362	187061	3	30.39	81.78	2.94	--------	--------
363	187062	3	32.09	79.77	4.41	--------	--------
364	187082	2	31.43	78.24	14.45	--------	--------
365	1012HWL	3	30.82	81.54	2.80	2.13	(+)0.67
366	1022RS	3	30.92	81.11	2.47	2.39	(+)0.09
367	1101HWL	3	30.45	81.75	2.88	2.63	(+)0.26
368	1124HWL	3	30.44	81.82	5.01	3.54	(+)1.47
369	1136HWL	3	30.41	81.78	9.56	5.92	(+)3.64
370	138HWL	3	30.69	81.23	25565.60	25806.38	**(-)**240.78
371	**142HWL**	**3**	**30.80**	**81.57**	**357.20**	**337.86**	(+)**19.34**
372	**145HWL**	**3**	**30.68**	**81.47**	**41828.60**	**41698.35**	(+)**130.25**
373	**148HWL**	**3**	**30.76**	**81.59**	**158.49**	**123.59**	(+)**34.90**
374	**15002HWL**	**3**	**30.60**	**82.07**	**17.53**	**43.66**	**(-)26.13**
375	**15003HWL**	**3**	**30.59**	**82.08**	**23.00**	**5.30**	(+)**17.70**
376	**150HWL**	**3**	**30.64**	**82.14**	**6137.30**	**5974.58**	(+)**162.72**
377	**159HWL**	**3**	**30.55**	**81.74**	**16.83**	**15.60**	(+)**1.23**
378	205HWL	3	30.79	81.56	6.70	5.56	(+)1.14
379	206HWL	3	30.78	81.55	4.44	6.83	**(-)**2.39
380	**210HWL**	**3**	**30.77**	**81.55**	**54.00**	**60.24**	**(-)6.24**
381	**211HWL**	**3**	**30.77**	**81.56**	**10.79**	**9.76**	(+)**1.03**
382	**211HWL**	**3**	**30.52**	**81.70**	**13.68**	**10.80**	(+)**2.88**
383	**32LWL**	**1**	**32.33**	**78.72**	**122.01**	**109.62**	(+)**12.39**
384	385HWL	3	30.78	81.54	5.00	3.54	(+)1.46

385	**440HWL**	**3**	**30.45**	**81.72**	**10.76**	**9.29**	(+)**1.47**
386	441HWL	3	30.45	81.70	3.92	3.30	(+)0.63
387	**607RS**	**3**	**30.91**	**81.17**	**77.20**	**76.41**	(+)**0.80**
388	**608RS**	**3**	**30.93**	**81.09**	**19.99**	**14.36**	(+)**5.64**
389	608RS	3	30.93	81.10	8.77	4.44	(+)4.33
390	**616RS**	**3**	**30.92**	**81.11**	**13.69**	**11.76**	(+)**1.93**
391	824HWL	3	30.42	81.76	4.90	4.83	(+)0.07
392	8258HWL	3	30.56	81.71	7.63	7.66	**(-)**0.03
393	8263RS	3	30.92	81.10	2.72	1.74	(+)0.99
394	8500HWL	3	30.57	82.12	2.61	1.86	(+)0.74
395	8501HWL	3	30.55	82.16	5.41	4.85	(+)0.56
396	8510RS	3	30.46	81.77	4.43	3.85	(+)0.57
397	**8511HWL**	**3**	**30.53**	**81.75**	**15.77**	**13.64**	(+)**2.12**
398	**8515HWL**	**3**	**30.70**	**81.36**	**72.81**	**35.98**	(+)**36.83**
399	8516RS	3	30.92	81.13	4.66	4.62	(+)0.04
400	8527RS	3	31.23	79.31	5.46	4.65	(+)0.81
401	8528RS	3	31.37	78.80	3.66	2.80	(+)0.87
402	8597RS	3	31.37	81.02	2.99	2.31	(+)0.67
403	8610HWL	3	30.95	81.89	6.77	6.66	(+)0.11
404	8611HWL	3	30.95	81.89	7.51	7.19	(+)0.32
405	9010HWL	3	30.83	81.53	5.19	8.60	**(-)**3.41
406	9011HWL	3	30.79	81.54	4.58	3.32	(+)1.26
407	9012HWL	3	30.78	81.52	2.30	2.82	**(-)**0.52
408	9013HWL	3	30.59	82.12	2.51	2.29	(+)0.22
409	9049RS	2	31.62	78.02	5.02	5.18	**(-)**0.16
410	9052HWL	3	30.77	81.55	6.11	6.06	(+)0.05
411	9065HWL	3	30.78	81.55	9.04	9.52	**(-)**0.48
412	**96HWL**	**3**	**31.31**	**79.60**	**36.94**	**59.81**	**(-)22.87**

6.6: STATUS OF LAKES AS IN SEPTEMBER2023

During the month of September 2023, a total of 05 scenes could were analysed out of which only 02 data products (2nd & 26th September) were having full coverage whereas the remaining (4th, 12th and 14th September) (Fig: 6.6 (a)-(e)). Based on the quality of the data and its coverage, a total 466 lakes could be mapped in comparison to 414 lakes which were mapped during 2022 comprising 67 lakes from the Spiti basin, 58 from the lower Satluj and 341 lakes from the Upper Satluj basin (Fig: 6.6 (e)). From further analysis of 466 Lakes, it is found that 270 lakes are such which have the area less than 5 ha comprising 45 from Spiti, 44 from Lower Satluj and 181 from Upper Satluj basin. Likewise, 113 lakes are such which falls within the areal range of 5-10ha comprising 16 from Spiti, 9 from Lower Satluj and 88 from Upper Satluj basin. Similarly, 83 lakes are such which have the area more than 10ha and are considered to be big lakes comprising 6 from Spiti, 5 from Lower Satluj and 72 from Upper Satluj basin (Fig. 6.6 (g)). Further analysis of 466 lakes reveals that 39 lakes are as the high-altitude wetlands comprising 11 wetlands having area less than 5ha, 13 are within the areal range of 5-10ha and 15 having area more than10ha and all these high-altitude wetlands forms part of the Upper Satluj basin (Fig. 6.6 (h)). When these 466 lakes are seen temporally w.r.t. 2022 data, 438 lakes out of 466 lakes could be compared for their temporal variation and out of which 280 lakes/wetlands have shown an increasing trend in their water spread, whereas 158 lakes/wetlands shown a reducing trend in their water spread with reference to 2022 data. The lakes which could not be compared forms the base line data for next year monitoring (Table: 6.6). Further analysis of the bigger lakes with area more than 10 ha reflects that total number of such lakes/water bodies has increased to 83 (2023) from 76 (2022) and 66 (2021) reflecting that the lakes with ids 187013, 187016, 187036, 187047, 187051, 187059, 187068 and 187082 (Sangla Dam) are the new lakes mapped during 2023. Further, 07 lakes (23,827, 8121, 8280, 8288, 8584 and 9027) mapped as big lakes with area more than 10ha in 2022 have shown reduction in their water spread and have been counted in the lower category with area 5-10 ha in 2023, whereas 04 lakes (173, 634, 8289, 15003HWL, 211HWL, 440 HWL) mapped in 5-10 ha category and 02 lakes 8289 and 15003 with area less than 5ha in 2022 have taken in the bigger lakes category during 2023 by virtue of the increase in their water spread. The 12 lakes with ids RS are mainly formed due to the accumulation of water along the main Satluj river course in the Upper Satluj sub basin (11 lakes) and lower Satluj sub basin (only one lake). The lakes/wetlands which could not be compared were either new one or could not be mapped due to technical reasons like the data quality or the cloud cover or the snow cover.

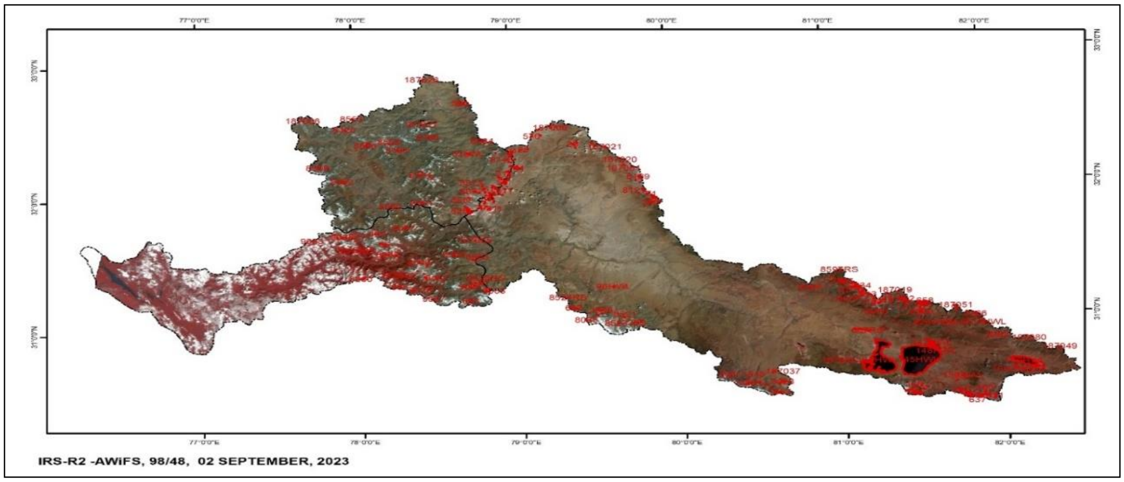


Fig. 6.6 (a): IRS, R2, AWiFS, 98/48, 02nd September, 2023

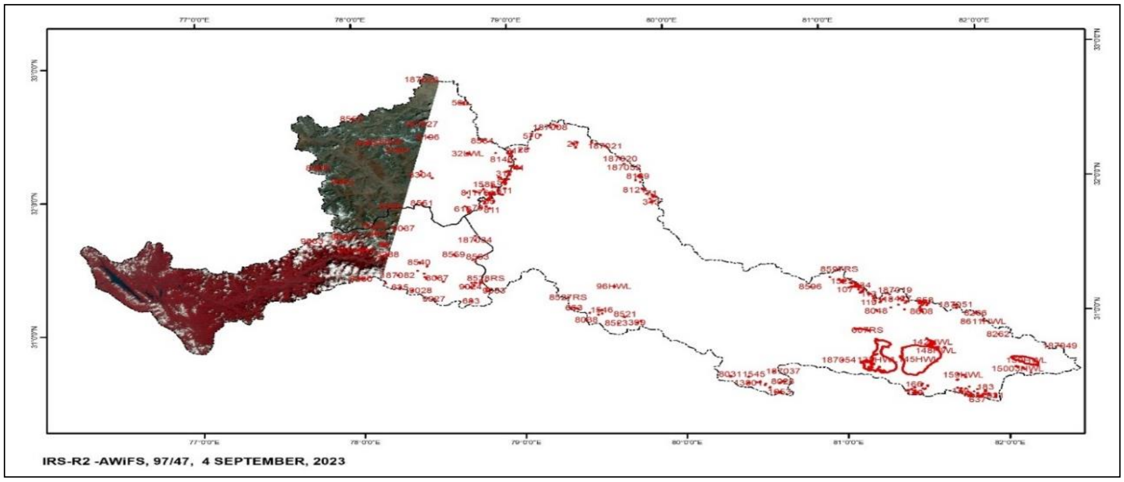


Fig. 6.6 (b): IRS, R2A, AWiFS, 97/47, 4th September, 2023

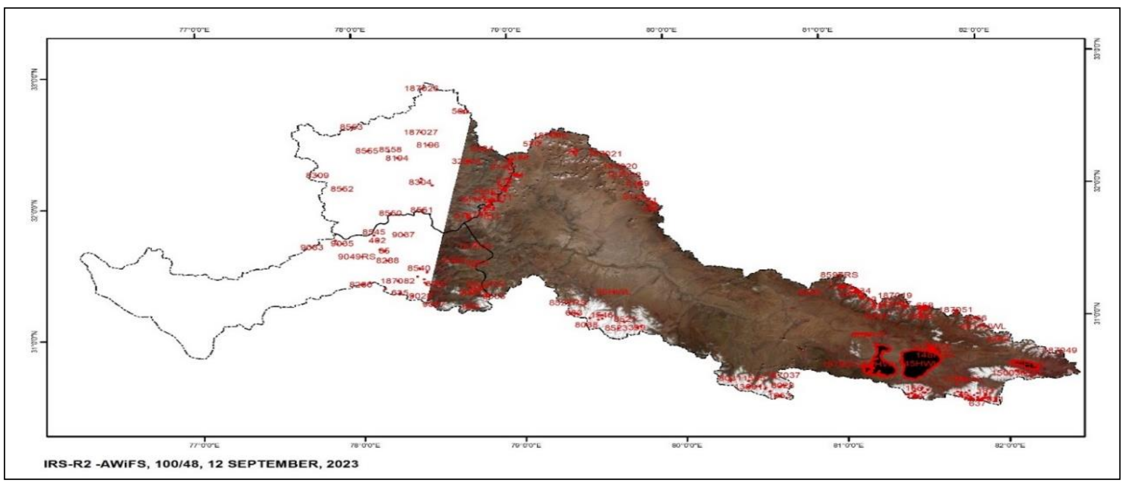


Fig. 6.6 (c): IRS, R2, AWiFS, 100/48, 12th September, 2023

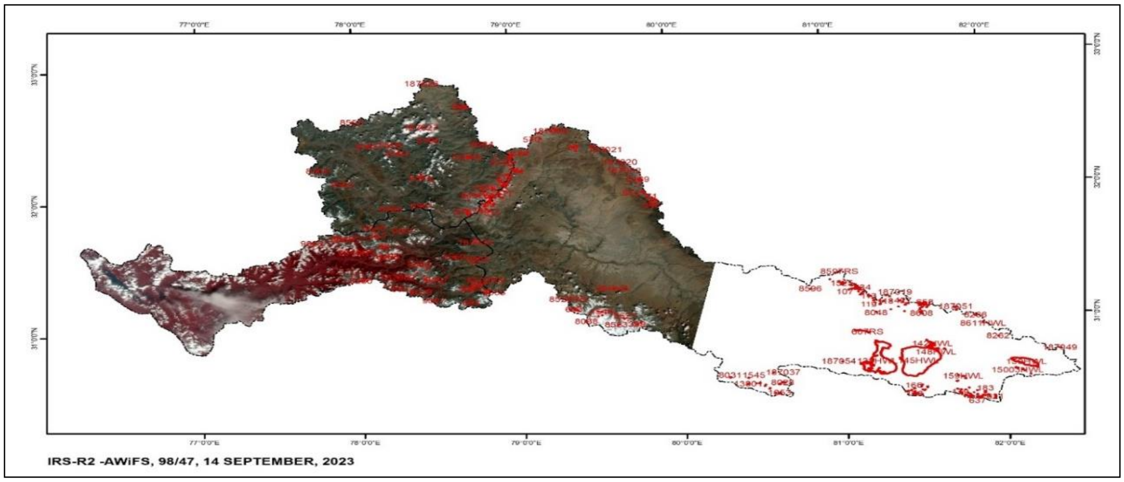


Fig. 6.6 (d): IRS, R2, AWiFS, 98/47, 14th September, 2023

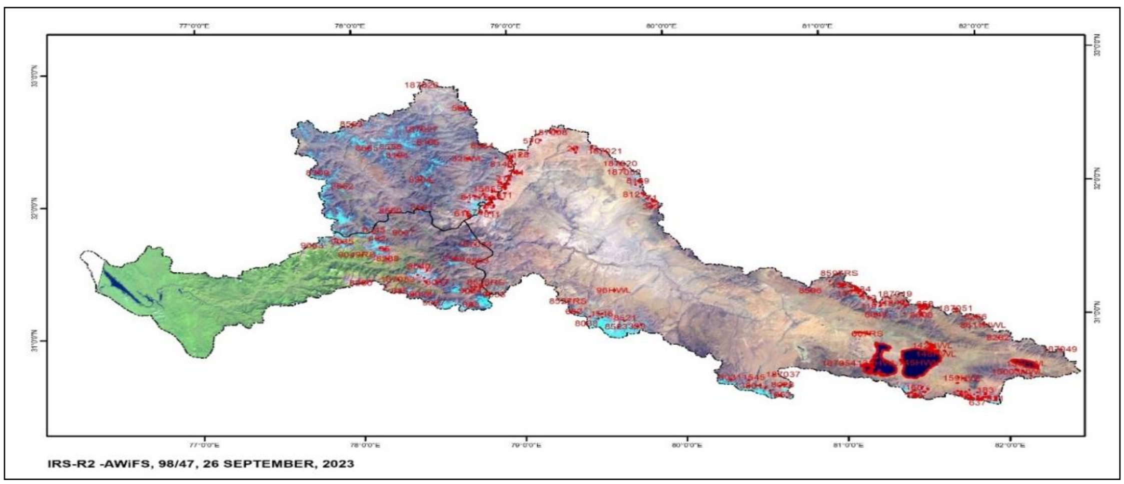


Fig. 6.6 (e): IRS, R2, AWiFS, 98/47, 26th September, 2023

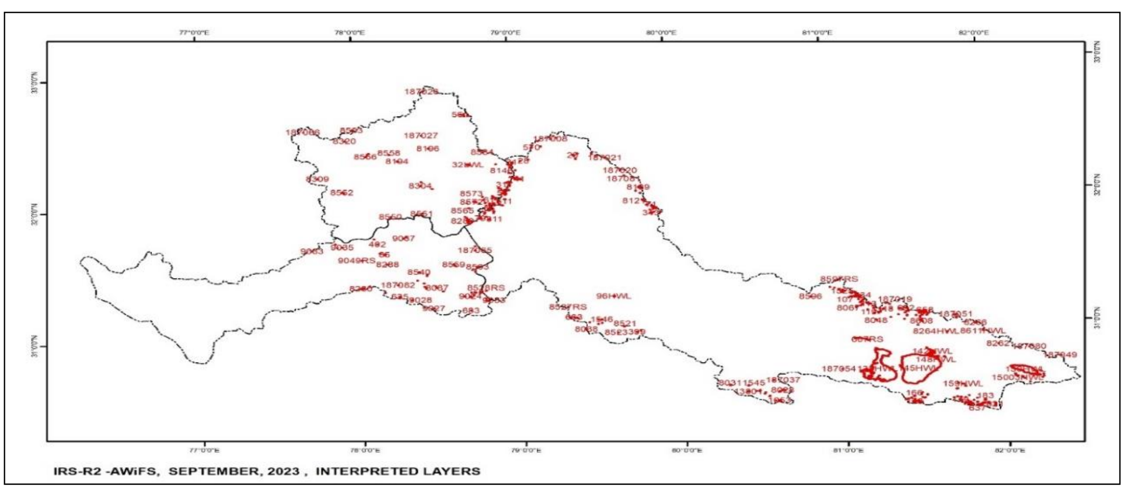


Fig. 6.6 (f): IRS- R2, AWiFS, September, 2023, Interpreted Layer

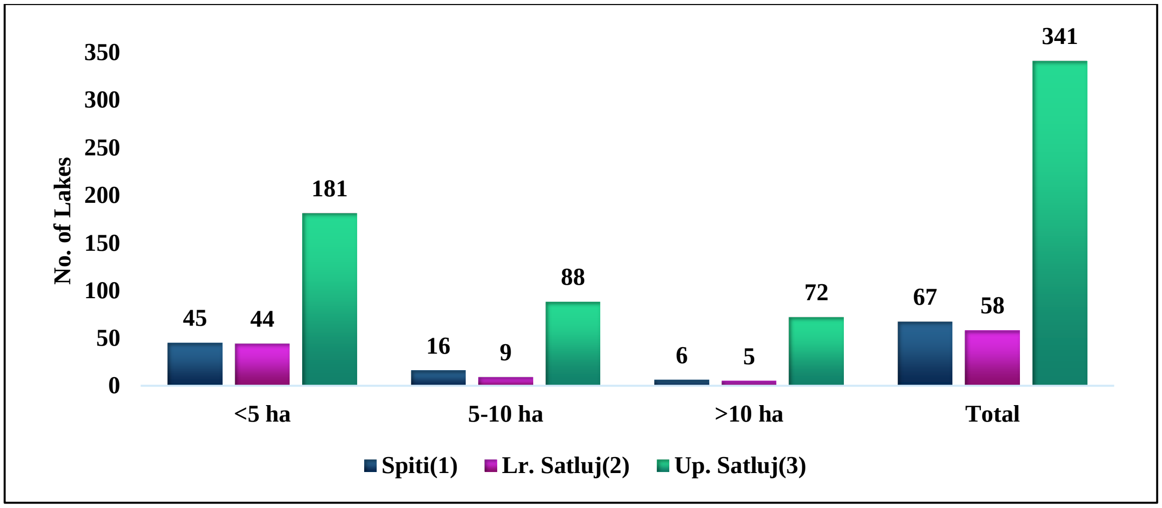


Fig. 6.6(g): No. of Lakes based on IRS- R2, AWiFS, September, 2023

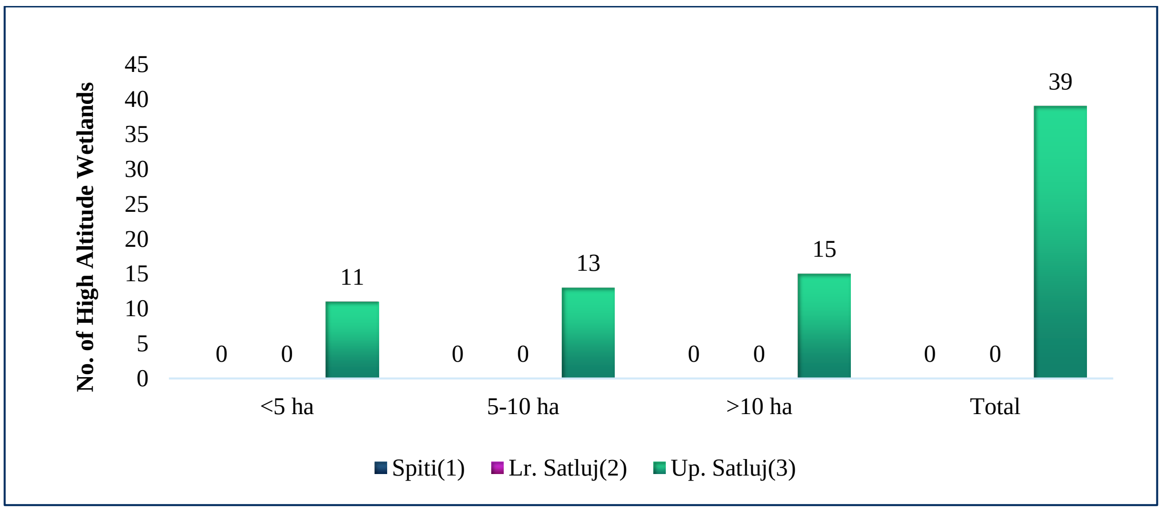


Fig. 6.6(h): No. High altitude wetland lakes based on IRS- R2, AWiFS, September, 2023

Table: 6.6 Aerial Extent of lakes as on 16th September, 2023

S. No.	Lake Id.	Basin Number	Latitude	Longitude	Aerial Extent on Sept 2023 (Ha.)	Aerial Extent on Sept 2022 (Ha.)	Change in Area w.r.t. Sept. 2022 (ha.)
1	23	3	32.39	79.42	9.59	13.65	(-)4.06
2	**25**	**3**	**32.38**	**79.39**	**22.13**	**36.04**	(-)**13.90**
3	28	3	32.35	79.05	6.90	7.89	(-)0.99
4	**31**	**3**	**32.34**	**79.00**	**10.38**	**10.17**	(+)**0.22**
5	39	3	32.22	79.03	8.57	9.36	(-)0.79
6	**41**	**3**	**32.21**	**79.04**	**27.98**	**31.23**	(-)**3.25**

7	51	3	32.12	78.94	5.53	7.23	(-)1.69
8	**54**	**3**	**32.11**	**78.93**	**14.25**	**12.81**	(+)**1.44**
9	**55**	**3**	**32.11**	**78.94**	**11.82**	**12.05**	(-)**0.23**
10	60	3	32.03	78.87	8.38	9.68	(-)1.31
11	**61**	**1**	**32.03**	**78.84**	**24.79**	**23.61**	(+)**1.18**
12	**62**	**3**	**32.02**	**78.87**	**12.81**	**13.89**	(-)**1.08**
13	63	3	32.02	78.88	3.91	3.90	(+)0.01
14	**65**	**3**	**31.99**	**78.84**	**24.90**	**33.21**	(-)**8.31**
15	**71**	**3**	**31.98**	**79.87**	**11.58**	**13.20**	(-)**1.62**
16	74	3	31.97	79.88	4.31	5.67	(-)1.36
17	**79**	**3**	**31.92**	**78.78**	**21.20**	**23.52**	(-)**2.32**
18	**85**	**2**	**31.66**	**78.17**	**45.13**	**47.64**	(-)**2.51**
19	106	3	31.24	81.10	6.09	6.29	(-)0.20
20	107	3	31.24	81.08	8.08	6.56	(+)1.51
21	**112**	**3**	**31.20**	**81.15**	**14.91**	**17.43**	(-)**2.52**
22	**113**	**3**	**31.18**	**81.19**	**56.57**	**53.61**	(+)**2.95**
23	**114**	**3**	**31.18**	**81.15**	**25.79**	**30.50**	(-)**4.71**
24	**118**	**3**	**31.14**	**81.28**	**19.15**	**19.62**	(-)**0.47**
25	119	3	31.13	81.23	6.07	7.90	(-)1.83
26	122	3	31.11	81.43	5.24	4.41	(+)0.84
27	166	3	30.47	81.43	8.56	6.03	(+)2.53
28	**173**	**3**	**30.45**	**81.68**	**10.74**	**7.98**	(+)**2.76**
29	**178**	**3**	**30.43**	**81.43**	**229.39**	**229.97**	(-)**0.59**
30	**179**	**3**	**30.43**	**81.71**	**29.56**	**23.75**	(+)**5.81**
31	**183**	**3**	**30.43**	**81.87**	**27.68**	**24.78**	(+)**2.90**
32	**184**	**3**	**30.42**	**81.72**	**25.56**	**14.75**	(+)**10.80**
33	**196**	**3**	**30.39**	**81.89**	**10.99**	**12.86**	(-)**1.87**
34	**312**	**3**	**32.33**	**78.97**	**10.88**	**11.87**	(-)**0.99**
35	**313**	**3**	**32.32**	**78.98**	**10.75**	**12.65**	(-)**1.90**
36	315	1	32.19	78.97	7.63	6.80	(+)0.82
37	**317**	**3**	**32.16**	**78.98**	**12.28**	**11.30**	(+)**0.98**
38	**319**	**3**	**31.98**	**78.84**	**16.97**	**18.56**	(-)**1.59**
39	330	1	32.13	77.92	2.98	3.57	(-)0.59
40	**343**	**3**	**31.93**	**79.86**	**37.31**	**36.62**	(+)**0.69**
41	**399**	**3**	**31.03**	**79.73**	**15.98**	**16.33**	(-)**0.35**
42	402	2	31.74	78.12	2.95	3.47	(-)0.52
43	413	3	32.22	79.01	4.91	4.10	(+)0.80
44	414	1	32.26	78.98	2.67	3.33	(-)0.66
45	415	3	32.33	79.00	3.07	3.04	(+)0.03
46	416	3	32.45	79.19	5.14	4.21	(+)0.93
47	422	3	31.23	81.07	4.13	4.10	(+)0.03
48	**423**	**3**	**31.22**	**81.16**	**11.81**	**11.77**	(+)**0.03**

49	426	3	31.09	81.50	7.75	7.67	(+)0.08
50	427	3	31.14	81.38	9.39	9.49	(-)0.09
51	431	3	31.11	81.50	9.97	9.54	(+)0.44
52	432	3	31.08	81.52	4.01	3.53	(+)0.48
53	438	3	30.40	81.74	6.64	4.66	(+)1.98
54	439	3	30.43	81.72	5.44	4.61	(+)0.83
55	561	1	32.71	78.69	6.92	7.43	(-)0.51
56	562	3	32.28	79.02	3.09	3.37	(-)0.28
57	563	1	32.23	78.98	4.31	3.10	(+)1.22
58	570	3	32.45	79.13	6.99	6.05	(+)0.94
59	592	3	32.12	79.80	4.10	4.59	(-)0.49
60	607	3	31.25	81.13	6.86	5.32	(+)1.54
61	**611**	**3**	**32.06**	**78.94**	**10.07**	**10.04**	(+)**0.03**
62	616	1	31.91	78.70	6.26	9.23	(-)2.97
63	**621**	**3**	**30.38**	**81.93**	**95.25**	**92.63**	(+)**2.62**
64	622	3	31.27	81.08	3.02	3.30	(-)0.28
65	632	3	31.14	79.37	4.43	6.66	(-)2.23
66	**634**	**3**	**31.25**	**81.14**	**12.77**	**9.77**	(+)**2.99**
67	**635**	**2**	**31.34**	**78.25**	**21.51**	**25.13**	(-)**3.62**
68	636	3	31.27	81.11	5.08	4.39	(+)0.69
69	**637**	**3**	**30.38**	**81.84**	**16.66**	**10.62**	(+)**6.05**
70	638	3	30.39	81.84	7.00	1.97	(+)5.02
71	638	3	30.38	81.83	3.87	2.53	(+)1.33
72	641	3	31.96	79.89	4.83	3.81	(+)1.02
73	645	3	31.27	81.09	7.41	8.05	(-)0.65
74	646	3	31.26	81.12	4.31	1.72	(+)2.59
75	647	3	31.26	81.12	5.97	3.64	(+)2.32
76	648	3	31.24	81.12	5.43	4.19	(+)1.24
77	649	3	31.24	81.13	4.31	2.49	(+)1.83
78	651	3	31.13	81.40	6.66	7.97	(-)1.31
79	652	3	31.14	81.42	9.66	7.12	(+)2.54
80	655	3	31.10	81.51	7.77	7.22	(+)0.55
81	656	3	31.10	81.53	5.07	3.19	(+)1.88
82	657	3	31.10	81.54	6.71	5.84	(+)0.87
83	**658**	**3**	**31.12**	**81.54**	**12.10**	**11.17**	(+)**0.93**
84	663	3	31.15	79.34	6.90	6.14	(+)0.76
85	**683**	**2**	**31.22**	**78.70**	**11.03**	**13.27**	(-)**2.24**
86	**688**	**3**	**30.41**	**81.82**	**10.81**	**10.39**	(+)**0.42**
87	**811**	**3**	**31.91**	**78.84**	**19.52**	**13.90**	(+)**5.61**
88	825	3	31.25	81.11	3.38	2.01	(+)1.37
89	827	3	31.19	81.14	8.13	10.60	(-)2.46
90	828	3	31.21	81.15	2.69	2.00	(+)0.69

91	840	3	30.40	81.79	6.12	3.69	(+)2.43
92	865	3	30.40	81.77	3.73	3.63	(+)0.09
93	870	1	32.13	78.93	1.65	1.37	(+)0.28
94	885	3	31.93	79.88	2.46	2.45	(+)0.01
95	888	3	31.20	81.15	1.70	1.72	(-)0.02
96	895	3	30.38	81.84	2.70	2.47	(+)0.23
97	964	3	30.41	81.77	2.74	2.54	(+)0.20
98	1030	3	31.19	81.18	2.22	3.20	(-)0.97
99	1038	3	32.13	79.80	5.58	4.97	(+)0.61
100	**1053**	**3**	**30.48**	**80.59**	**24.67**	**19.94**	(+)**4.72**
101	**1133**	**3**	**30.42**	**81.87**	**16.33**	**14.31**	(+)**2.03**
102	1142	3	30.40	81.77	1.36	2.74	(-)1.38
103	1149	3	30.40	81.77	8.55	7.15	(+)1.40
104	1155	3	31.99	79.84	2.48	3.52	(-)1.04
105	1510	3	31.09	81.56	3.77	2.28	(+)1.49
106	1511	3	31.08	81.42	3.66	4.66	(-)0.99
107	1512	3	31.08	81.42	3.05	3.46	(-)0.41
108	1515	3	31.10	81.42	4.10	5.27	(-)1.16
109	1516	3	31.15	81.41	2.67	2.74	(-)0.07
110	1519	3	31.16	81.21	3.39	2.40	(+)0.99
111	1522	3	31.17	81.11	3.30	3.29	(+)0.01
112	1524	3	31.29	81.03	7.82	5.98	(+)1.84
113	**1525**	**3**	**31.28**	**81.03**	**24.46**	**24.34**	(+)**0.12**
114	**1531**	**3**	**31.97**	**78.87**	**12.28**	**12.44**	(-)**0.15**
115	1532	3	31.96	78.87	5.61	4.28	(+)1.33
116	1543	3	30.45	81.39	4.83	3.77	(+)1.06
117	1545	3	30.60	80.40	6.03	7.97	(-)1.94
118	1546	3	31.13	79.51	7.26	8.56	(-)1.30
119	1552	1	32.26	78.99	0.69	1.42	(-)0.73
120	1568	3	32.01	78.84	2.73	2.72	(+)0.01
121	1585	1	32.09	78.86	2.95	2.94	(+)0.01
122	1606	3	32.22	79.00	6.32	1.68	(+)4.63
123	6021	3	31.12	81.26	3.29	1.35	(+)1.94
124	6045	2	31.50	78.43	1.34	1.13	(+)0.21
125	6060	3	31.93	78.82	1.75	1.75	----------
126	6088	3	31.05	81.51	3.40	3.37	(+)0.03
127	7004	3	31.93	78.82	2.55	2.54	(+)0.01
128	8005	3	30.38	81.83	1.11	1.10	(+)0.01
129	8008	3	30.40	81.78	0.90	1.51	(-)0.60
130	8011	3	30.48	80.57	6.27	5.64	(+)0.63
131	8024	3	30.54	80.51	2.49	2.76	(-)0.27
132	**8027**	**3**	**30.55**	**80.47**	**16.39**	**15.60**	(+)**0.79**

133	8028	3	32.17	78.97	2.69	2.60	(+)0.08
134	8028	3	30.55	80.62	8.36	8.31	(+)0.05
135	8029	3	30.55	80.63	3.98	3.95	(+)0.03
136	**8031**	**3**	**30.61**	**80.29**	**22.83**	**23.21**	(-)**0.38**
137	8037	3	31.06	79.41	6.68	6.65	(+)0.03
138	8038	3	31.06	79.41	7.87	7.84	(+)0.03
139	8047	3	31.13	79.49	2.69	4.16	(-)1.47
140	8048	3	31.06	81.23	7.13	6.79	(+)0.34
141	8052	3	31.08	81.55	4.49	4.03	(+)0.46
142	8053	3	31.09	81.55	1.38	2.63	(-)1.25
143	8054	3	31.09	81.53	3.60	3.68	(-)0.08
144	8056	3	31.10	81.41	1.95	2.58	(-)0.62
145	8057	3	31.12	81.26	6.01	5.27	(+)0.74
146	8058	3	31.11	81.42	2.05	2.03	(+)0.02
147	8062	3	31.14	81.18	4.29	4.36	(-)0.06
148	8063	3	31.14	81.26	2.03	2.84	(-)0.81
149	**8065**	**3**	**31.15**	**81.22**	**13.96**	**14.08**	(-)**0.12**
150	8067	3	31.16	81.11	4.51	4.12	(+)0.39
151	8071	2	31.29	78.80	2.86	2.71	(+)0.15
152	8074	3	31.22	81.13	4.20	5.77	(-)1.57
153	8076	3	31.23	81.14	2.74	1.15	(+)1.59
154	8077	2	31.33	78.70	3.04	4.91	(-)1.87
155	**8079**	**3**	**31.23**	**81.14**	**13.42**	**12.54**	(+)**0.88**
156	8083	3	31.28	81.03	2.33	2.43	(-)0.10
157	8086	3	31.30	81.01	4.09	4.82	(-)0.73
158	8087	2	31.40	78.49	5.21	7.96	(-)2.75
159	8088	3	31.32	80.95	2.70	2.98	(-)0.28
160	8096	1	31.93	78.70	1.68	1.68	------
161	8101	1	31.93	78.68	1.33	1.33	------
162	8107	3	31.96	79.90	6.90	2.19	(+)4.72
163	8117	1	32.04	78.76	2.33	2.71	(-)0.38
164	8118	1	32.04	78.76	1.36	1.83	(-)0.47
165	8121	3	32.02	79.83	5.86	13.96	(-)8.10
166	8123	3	32.07	78.89	3.00	2.99	(+)0.01
167	8125	3	32.03	79.81	5.77	2.62	(+)3.16
168	**8127**	**1**	**32.06**	**78.81**	**11.10**	**11.07**	(+)**0.03**
169	8131	3	32.12	78.95	4.25	4.20	(+)0.05
170	8137	1	32.14	78.92	5.20	4.43	(+)0.77
171	8138	3	32.15	78.96	2.44	3.14	(-)0.70
172	8139	3	32.12	79.79	8.51	8.10	(+)0.42
173	8141	1	32.19	78.96	3.63	2.96	(+)0.67
174	8142	3	32.21	79.02	3.32	3.77	(-)0.45

175	8143	3	32.22	79.01	3.10	2.05	(+)1.04
176	**8146**	**3**	**32.30**	**78.98**	**14.39**	**18.62**	(-)**4.23**
177	8153	3	32.35	79.10	4.51	3.68	(+)0.82
178	8154	3	32.35	79.40	4.54	2.75	(+)1.79
179	8159	3	32.39	79.51	2.60	1.18	(+)1.42
180	8170	2	31.40	78.42	2.69	3.16	(-)0.47
181	8171	2	31.41	78.41	1.65	2.69	(-)1.04
182	8172	2	31.44	78.41	2.35	3.00	(-)0.65
183	8173	2	31.46	78.37	2.65	3.43	(-)0.78
184	**8194**	**1**	**32.36**	**78.27**	**11.01**	**13.97**	(-)**2.97**
185	8196	1	32.46	78.47	8.34	6.60	(+)1.74
186	8236	3	31.04	79.75	7.75	7.07	(+)0.69
187	**8249**	**3**	**30.40**	**81.85**	**25.12**	**25.98**	(-)**0.87**
188	8251	3	30.40	81.88	9.02	4.80	(+)4.22
189	8252	3	30.47	81.43	1.63	1.92	(-)0.28
190	8262	3	30.84	81.98	4.87	4.15	(+)0.72
191	8265	3	31.10	79.49	4.07	4.06	(+)0.02
192	**8266**	**3**	**31.01**	**81.85**	**30.64**	**28.57**	(+)**2.07**
193	8272	3	31.12	81.25	2.70	3.22	(-)0.52
194	8277	2	31.42	78.07	1.96	3.01	(-)1.05
195	8280	2	31.41	78.01	7.52	10.30	(-)2.79
196	8281	2	31.41	78.03	0.67	5.35	(-)4.68
197	8281	2	31.41	78.03	5.62	6.53	(-)0.91
198	8282	3	31.31	80.98	2.02	1.78	(+)0.24
199	8286	3	32.04	78.90	2.69	2.68	(+)0.01
200	8287	2	31.59	78.18	1.39	1.94	(-)0.55
201	8288	2	31.59	78.18	8.71	10.46	(-)1.76
202	**8289**	**1**	**31.90**	**78.72**	**15.19**	**3.84**	(+)**11.35**
203	8292	3	31.93	79.92	1.61	1.60	(+)0.01
204	8293	3	31.95	79.86	1.68	1.77	(-)0.09
205	8295	1	32.04	78.70	2.41	2.40	(+)0.01
206	8296	3	32.02	79.82	2.39	4.86	(-)2.47
207	8299	3	32.12	78.95	3.64	1.84	(+)1.81
208	**8304**	**1**	**32.18**	**78.41**	**11.06**	**10.20**	(+)**0.86**
209	8307	1	32.20	78.42	5.69	5.68	(+)0.01
210	8309	1	32.24	77.76	5.61	4.77	(+)0.84
211	8320	1	32.53	77.94	4.57	6.88	(-)2.30
212	8506	3	30.39	81.78	1.79	1.78	(+)0.01
213	8507	3	30.39	81.77	1.21	1.16	(+)0.05
214	8508	3	30.40	81.77	2.17	2.09	(+)0.08
215	8509	3	30.40	81.76	1.19	1.18	(+)0.01
216	8514	3	30.46	81.41	3.24	2.76	(+)0.48

217	**8517**	**3**	**30.51**	**80.53**	**12.30**	**11.76**	(+)**0.54**
218	8518	3	30.53	80.50	4.15	3.59	(+)0.56
219	8520	3	31.07	79.65	2.00	2.00	(-)0.01
220	8521	3	31.07	79.65	2.34	2.66	(-)0.32
221	8522	3	31.08	79.65	1.88	1.84	(+)0.04
222	8523	3	31.11	79.44	2.26	2.25	(+)0.01
223	8523	3	31.03	79.61	2.88	2.96	(-)0.09
224	8524	3	31.15	79.36	2.35	2.82	(-)0.48
225	8525	3	31.16	79.32	1.26	1.25	------
226	8529	3	31.32	78.80	0.85	0.85	------
227	8530	3	31.31	78.79	1.00	0.94	(+)0.06
228	8531	2	31.36	78.72	2.77	4.59	(-)1.82
229	8532	2	31.36	78.70	2.71	2.45	(+)0.27
230	8537	2	31.49	78.43	1.94	1.87	(+)0.07
231	8538	2	31.49	78.43	2.98	4.84	(-)1.85
232	8539	2	31.52	78.38	5.00	5.17	(-)0.17
233	8540	2	31.52	78.38	8.92	9.86	(-)0.94
234	8541	2	31.37	78.16	3.26	2.89	(+)0.37
235	8543	2	31.67	78.14	4.37	4.00	(+)0.37
236	8545	2	31.78	78.10	1.31	3.56	(-)2.25
237	8546	2	31.78	78.10	2.32	4.04	(-)1.73
238	8549	1	31.79	78.31	1.73	4.01	(-)2.29
239	8550	1	31.95	78.22	1.33	3.46	(-)2.13
240	8551	1	31.97	78.42	8.79	9.97	(-)1.18
241	8552	1	32.14	77.91	4.46	4.25	(+)0.21
242	8553	1	32.61	77.99	7.28	5.77	(+)1.50
243	8554	1	32.43	78.09	2.85	3.51	(-)0.66
244	8555	1	32.42	78.08	4.96	4.95	(+)0.01
245	8556	1	32.40	78.07	5.52	4.35	(+)1.17
246	8557	1	32.40	78.07	2.35	2.35	-------
247	8558	1	32.42	78.22	4.41	3.46	(+)0.94
248	8559	2	31.58	78.60	4.84	5.07	(-)0.23
249	8560	2	31.56	78.61	4.25	5.73	(-)1.48
250	8561	2	31.53	78.72	3.58	3.57	(+)0.01
251	8562	2	31.52	78.73	4.12	6.74	-2.63
252	8563	2	31.55	78.75	7.73	5.58	(+)2.15
253	8564	1	31.91	78.71	1.89	1.63	(+)0.26
254	8565	1	32.00	78.71	1.86	1.86	------
255	8566	3	31.93	78.82	1.14	1.14	------
256	8567	3	31.96	78.81	6.13	6.11	(+)0.02
257	8568	3	31.97	78.80	1.33	1.37	(-)0.04
258	8569	3	32.00	78.85	1.62	2.16	(-)0.54

259	8570	1	32.01	78.82	2.42	2.42	(+)0.01
260	8571	1	32.03	78.78	1.46	1.45	-------
261	8572	1	32.04	78.76	2.41	3.24	(-)0.83
262	8573	1	32.08	78.80	1.86	1.86	------
263	8574	1	32.07	78.86	1.29	1.29	------
264	8575	3	32.02	78.91	2.39	2.38	(+)0.01
265	8576	3	32.12	78.95	2.15	2.45	(-)0.29
266	8577	1	32.14	78.91	2.30	1.91	(+)0.39
267	8580	3	32.32	78.99	3.22	4.40	(-)1.17
268	8581	1	32.33	78.90	2.31	3.24	(-)0.94
269	8584	1	32.42	78.82	8.42	11.73	(-)3.31
270	8588	3	32.38	79.51	0.66	2.85	(-)2.19
271	8590	3	32.13	79.80	4.98	4.96	(+)0.02
272	8596	3	31.25	80.83	6.15	6.37	(-)0.22
273	8598	3	31.28	81.02	1.68	1.49	(+)0.19
274	8599	3	31.29	81.05	3.49	2.34	(+)1.15
275	8600	3	31.24	81.11	2.18	2.42	(-)0.24
276	8601	3	31.17	81.14	1.69	1.44	(+)0.25
277	8602	3	31.09	81.37	2.99	2.97	(+)0.02
278	8603	3	31.06	81.41	3.93	3.89	(+)0.03
279	8604	3	31.08	81.48	4.36	3.71	(+)0.65
280	8605	3	31.01	81.49	1.30	1.58	(-)0.28
281	8606	3	31.01	81.49	2.63	3.04	(-)0.42
282	8607	3	31.03	81.52	1.71	1.82	(-)0.11
283	8608	3	31.04	81.51	5.05	4.97	(+)0.09
284	8609	3	31.09	81.55	2.08	2.51	(-)0.43
285	8614	3	31.10	79.51	1.44	1.77	(-)0.33
286	8616	2	31.71	78.74	2.98	4.14	(-)1.15
287	8654	2	31.72	77.87	4.57	4.35	(+)0.23
288	9000	3	31.27	81.08	1.53	1.39	(+)0.14
289	9001	3	31.24	81.09	2.03	2.62	(-)0.59
290	9002	3	31.11	81.25	1.64	1.62	(+)0.01
291	9003	3	31.07	81.32	2.99	4.93	(-)1.94
292	9004	3	31.07	81.51	1.89	1.83	(+)0.06
293	9005	3	31.06	81.50	1.12	1.11	(+)0.01
294	9006	3	31.11	81.52	3.76	3.85	(-)0.09
295	9007	3	31.12	81.54	5.86	4.05	(+)1.81
296	9008	3	31.04	81.51	4.04	4.01	(+)0.04
297	9009	3	31.04	81.51	3.27	3.24	(+)0.03
298	9015	3	30.45	81.38	8.31	8.24	(+)0.07
299	9016	3	30.46	81.41	1.72	4.04	(-)2.32
300	9017	3	30.55	80.45	3.90	4.37	(-)0.47

301	9018	2	31.36	78.77	2.70	3.47	(-)0.78
302	9019	2	31.36	78.76	1.26	1.23	(+)0.03
303	9020	2	31.35	78.76	2.25	5.48	(-)3.23
304	9021	2	31.36	78.73	4.37	4.03	(+)0.34
305	9022	2	31.34	78.72	2.91	4.31	(-)1.40
306	9024	2	31.33	78.70	4.61	4.60	(+)0.01
307	9025	2	31.33	78.66	2.69	3.02	(-)0.33
308	9026	2	31.33	78.66	2.47	3.16	(-)0.69
309	9027	2	31.25	78.46	4.73	10.79	(-)6.05
310	**9028**	**2**	**31.31**	**78.33**	**15.72**	**13.63**	(+)**2.08**
311	9029	2	31.42	78.07	2.67	3.85	(-)1.18
312	9030	2	31.37	78.53	2.55	2.54	------
313	9031	2	31.41	78.48	3.00	3.93	(-)0.93
314	9032	2	31.40	78.42	3.69	5.26	(-)1.57
315	9033	2	31.70	77.71	4.87	5.96	(-)1.09
316	9034	2	31.75	77.86	3.28	3.27	------
317	9035	2	31.72	77.90	8.35	7.54	(+)0.80
318	9037	2	31.78	78.29	2.20	3.88	(-)1.69
319	9040	1	32.09	78.91	2.26	2.25	(+)0.01
320	9041	1	32.08	78.87	4.20	4.19	(+)0.01
321	9043	3	32.01	78.93	3.92	3.91	(+)0.01
322	9044	1	32.03	78.82	5.31	5.29	(+)0.01
323	9045	1	32.01	78.85	1.98	1.98	(+)0.01
324	9046	3	31.95	78.81	2.98	1.68	(+)1.30
325	9047	3	31.93	78.78	7.91	7.89	(+)0.02
326	9048	3	31.93	78.78	3.17	3.16	(+)0.01
327	9049	1	31.90	78.72	1.32	0.74	(+)0.57
328	9050	1	31.89	78.70	2.16	2.16	(+)0.00
329	9051	1	31.88	78.71	1.40	1.40	(+)0.00
330	9052	2	31.33	78.70	3.25	4.63	(-)1.38
331	9053	2	31.30	78.80	3.76	4.49	(-)0.74
332	9056	3	31.15	81.22	4.03	3.40	(+)0.63
333	9058	3	31.97	79.88	6.26	8.48	(-)2.22
334	9059	3	31.96	79.88	4.75	3.77	(+)0.97
335	9060	3	31.96	79.88	4.60	4.15	(+)0.45
336	9062	3	31.99	79.84	5.66	6.17	(-)0.51
337	9064	1	32.06	78.88	9.55	9.52	(+)0.03
338	**13801**	**3**	**30.55**	**80.40**	**41.84**	**44.02**	(-)**2.18**
339	187 01	3	30.39	81.85	4.93	4.01	(+)0.91
340	**185001**	**3**	**30.41**	**81.75**	**10.75**	**11.50**	(-)**0.75**
341	187004	3	30.40	81.78	7.42	7.35	(+)0.07
342	187005	3	32.37	79.53	2.45	--------	--------

343	187006	3	32.46	79.13	3.52	--------	--------
344	187007	3	32.49	79.17	3.20	--------	--------
345	187008	3	32.51	79.25	5.07	--------	--------
346	187009	3	32.53	79.27	1.33	--------	--------
347	187010	3	32.51	79.29	2.41	--------	--------
348	187011	3	32.08	79.80	5.96	--------	--------
349	187012	1	32.03	78.86	8.87	--------	--------
350	**187013**	**3**	**31.24**	**81.11**	**17.35**	**--------**	**--------**
351	187014	3	30.92	81.14	4.71	--------	--------
352	187015	3	30.79	81.57	1.73	--------	--------
353	**187016**	**3**	**30.76**	**81.64**	**23.15**	**--------**	**--------**
354	187017	3	30.40	81.87	9.71	--------	--------
355	187018	3	31.17	81.32	1.47	--------	--------
356	187019	3	31.18	81.30	3.98	--------	--------
357	187020	3	32.25	79.68	7.55	--------	--------
358	187021	3	32.35	79.59	8.63	--------	--------
359	187022	3	32.35	79.59	5.79	--------	--------
360	187023	1	32.70	78.71	2.58	--------	--------
361	187024	1	32.70	78.73	2.08	--------	--------
362	187025	1	32.71	78.71	4.11	--------	--------
363	187026	1	32.89	78.45	8.40	--------	--------
364	187027	1	32.56	78.43	2.53	--------	--------
365	187028	1	32.15	78.49	7.21	--------	--------
366	187029	1	32.05	78.74	1.21	--------	--------
367	187030	1	32.04	78.75	1.11	--------	--------
368	187031	1	32.05	78.76	2.24	--------	--------
369	187035	3	32.12	78.95	8.49	--------	--------
370	**187036**	**3**	**30.55**	**80.60**	**10.95**	**--------**	**--------**
371	187037	3	30.63	80.56	5.01	--------	--------
372	187038	3	30.45	81.43	7.39	--------	--------
373	187039	3	30.43	81.47	1.60	--------	--------
374	187040	3	30.43	81.48	1.75	--------	--------
375	187041	3	30.46	81.50	2.26	--------	--------
376	187042	3	30.46	81.48	2.42	--------	--------
377	187043	3	30.45	81.49	1.84	--------	--------
378	187044	3	30.48	81.47	2.25	--------	--------
379	187045	3	30.49	81.48	2.34	--------	--------
380	187046	3	30.48	81.51	4.25	--------	--------
381	**187047**	**3**	**30.48**	**81.51**	**10.92**	**--------**	**--------**
382	187048	3	30.50	81.48	2.71	--------	--------
383	187049	3	30.73	82.36	2.69	--------	--------
384	187050	3	31.07	81.72	8.65	--------	--------

385	**187051**	**3**	**31.05**	**81.73**	**20.36**	**--------**	**--------**
386	187053	3	32.09	78.95	6.34	--------	--------
387	187054	3	30.70	81.00	5.71	--------	--------
388	187055	3	32.13	78.97	4.84	--------	--------
389	187056	3	31.14	81.33	1.88	--------	--------
390	**187059**	**3**	**30.39**	**81.82**	**21.53**	**--------**	**--------**
391	187060	3	30.42	81.80	2.23	--------	--------
392	187061	3	30.39	81.78	2.94	--------	--------
393	187062	3	32.09	79.77	4.41	--------	--------
394	187063	1	31.90	78.71	1.38	--------	--------
395	187064	1	31.90	78.70	0.72	--------	--------
396	187065	2	31.68	78.74	7.34	--------	--------
397	187066	1	32.60	77.68	2.66	--------	--------
398	187067	3	30.44	81.46	4.83	--------	--------
399	**187068**	**3**	**30.43**	**81.46**	**17.26**	**--------**	**--------**
400	187069	3	30.43	81.46	2.19	--------	--------
401	187070	3	30.60	82.25	2.12	--------	--------
402	187071	3	30.60	82.24	1.83	--------	--------
403	187072	3	30.58	82.25	0.84	--------	--------
404	187073	3	30.57	82.23	3.16	--------	--------
405	187074	3	30.59	82.21	8.69	--------	--------
406	187075	3	30.60	82.22	2.27	--------	--------
407	187076	3	30.59	82.22	2.73	--------	--------
408	187077	3	30.62	82.23	1.49	--------	--------
409	187078	3	30.62	82.23	1.38	--------	--------
410	187079	3	30.62	82.23	2.14	--------	--------
411	187080	3	30.81	82.17	2.71	--------	--------
412	187081	3	32.22	79.71	3.15	--------	--------
413	**187082**	**2**	**31.43**	**78.24**	**10.97**	--------	--------
414	1012HWL	3	30.82	81.54	2.80	2.13	(+)0.67
415	1022RS	3	30.92	81.11	2.47	2.39	(+)0.09
416	1101HWL	3	30.45	81.75	2.88	2.63	(+)0.26
417	1124HWL	3	30.44	81.82	5.01	3.54	(+)1.47
418	1136HWL	3	30.41	81.78	9.21	5.92	(+)3.29
419	**138HWL**	**3**	**30.69**	**81.23**	**25565.60**	**25806.38**	(-)**240.78**
420	**142HWL**	**3**	**30.80**	**81.57**	**357.20**	**337.86**	(+)**19.34**
421	**145HWL**	**3**	**30.68**	**81.47**	**41828.60**	**41698.35**	(+)**130.25**
422	**148HWL**	**3**	**30.76**	**81.59**	**158.49**	**123.59**	(+)**34.90**
423	15001HWL	3	30.61	82.07	9.10	9.01	(+)0.09
424	**15002HWL**	**3**	**30.60**	**82.07**	**18.40**	**43.66**	(-)**25.26**
425	**15003HWL**	**3**	**30.59**	**82.08**	**23.00**	**5.30**	(+)**17.70**
426	**150HWL**	**3**	**30.64**	**82.13**	**6067.26**	**5974.58**	(+)**92.68**

427	**159HWL**	**3**	**30.55**	**81.74**	**16.83**	**15.60**	(+)**1.23**
428	205HWL	3	30.79	81.56	6.70	5.56	(+)1.14
429	206HWL	3	30.78	81.55	4.44	6.83	(-)2.39
430	**210HWL**	**3**	**30.77**	**81.55**	**54.00**	**60.24**	(-)**6.24**
431	**211HWL**	**3**	**30.77**	**81.56**	**10.79**	**9.76**	(+)**1.03**
432	**211HWL**	**3**	**30.52**	**81.70**	**13.68**	**10.80**	(+)**2.88**
433	**32LWL**	**1**	**32.33**	**78.72**	**109.87**	**109.62**	(+)**0.25**
434	385HWL	3	30.78	81.54	5.00	3.54	(+)1.46
435	**440HWL**	**3**	**30.45**	**81.72**	**10.76**	**9.29**	(+)**1.47**
436	441HWL	3	30.45	81.70	3.92	3.30	(+)0.63
437	**607RS**	**3**	**30.91**	**81.17**	**77.20**	**76.41**	(+)**0.80**
438	**608RS**	**3**	**30.93**	**81.09**	**19.99**	**14.36**	(+)**5.64**
439	608RS	3	30.93	81.10	8.77	4.44	(+)4.33
440	**616RS**	**3**	**30.92**	**81.11**	**13.69**	**11.76**	(+)**1.93**
441	8055SG	3	31.11	81.22	5.36	5.54	(-)0.18
442	824HWL	3	30.42	81.76	5.95	4.83	(+)1.12
443	8258HWL	3	30.56	81.71	7.63	7.66	(-)0.03
444	8263RS	3	30.92	81.10	2.72	1.74	(+)0.99
445	8264HWL	3	30.95	81.67	4.07	3.09	(+)0.99
446	8500HWL	3	30.57	82.12	2.61	1.86	(+)0.74
447	8501HWL	3	30.54	82.16	5.41	4.85	(+)0.56
448	8502HWL	3	30.58	82.18	3.92	2.67	(+)1.25
449	8510RS	3	30.46	81.77	4.43	3.85	(+)0.57
450	**8511HWL**	**3**	**30.53**	**81.75**	**15.77**	**13.64**	(+)**2.12**
451	**8515HWL**	**3**	**30.70**	**81.36**	**72.81**	**35.98**	(+)**36.83**
452	8516RS	3	30.92	81.13	4.66	4.62	(+)0.04
453	8527RS	3	31.23	79.31	5.46	4.65	(+)0.81
454	8528RS	3	31.37	78.80	2.58	2.80	(-)0.22
455	8597RS	3	31.37	81.02	2.99	2.31	(+)0.67
456	8610HWL	3	30.95	81.89	6.77	6.66	(+)0.11
457	8611HWL	3	30.95	81.89	7.51	7.19	(+)0.32
458	9010HWL	3	30.83	81.53	5.19	8.60	(-)3.41
459	9011HWL	3	30.79	81.54	4.58	3.32	(+)1.26
460	9012HWL	3	30.78	81.52	2.30	2.82	(-)0.52
461	9013HWL	3	30.58	82.12	2.51	2.29	(+)0.22
462	9014HWL	3	30.41	81.78	3.35	3.32	(+)0.03
463	9049RS	2	31.62	78.02	5.02	5.18	(-)0.16
464	9052HWL	3	30.77	81.55	6.11	6.06	(+)0.05
465	9065HWL	3	30.78	81.55	9.04	9.52	(-)0.48
466	**96HWL**	**3**	**31.31**	**79.60**	**36.94**	**59.81**	(-)**22.87**

HWL- High Altitude Wetlands, RS- River Section, SG-Supra Glacial

6.7: STATUS OF LAKES AS ON OCTOBER 2023

During the month of October 2023, total three AWIFS data products were available for the period 05th, 6th and 15th October (Fig: 6. 7(a) – (c)). The analysis of these data products reveals the presence of 417 lakes in comparison to 174 (2022) in the entire catchment comprising 54 from Spiti, 43 from Lower Satluj and 320 from Upper Satluj sub basin (Fig.6.7 (d)). On analysing these 417 lakes further, it was found that 243 lakes were such which have the area less than 5 ha comprising 38 from Spiti, 32 from Lower Satluj and 173 from Upper Satluj basin. Further analysis reveals that 95 lakes were such which falls within the areal range of 5-10 ha comprising 11 from Spiti, 8 from Lower Satluj and 76 from Upper Satluj basin. Likewise, 79 lakes were such which have the area more than 10ha and are considered big lakes comprising 5 from Spiti, 3 from Lower Satluj basin and 36 from Upper Satluj basin (Fig. 6.7 (e). Besides this, when these 417 lakes were analysed for their source, 36 lakes were identified as high-altitude wetlands forming part of the Upper Satluj basin only with 10 having area less than 5ha, 11 with area between 5-10 ha and 15 with area more than 10 ha respectively (Fig.6.7 (f). On analysing these 417 lakes/wetlands for their temporal analysis with that of 2022, only 348 lakes/wetlands could be compared out of which 188 lakes/wetlands have shown a reducing trend in their water spread, whereas 160 lakes/wetlands shown an increasing trend in their water spread with reference to 2022 data (Table: 6.7). The remaining lakes/wetlands which could not be compared forms the base line data for their monitoring during the next ablation season, which may be due to the fact that either these lakes /wetlands were either not mapped during 2022 due to snow cover impacts or are the new one and thus mapped this year only. The 12 lakes with ids RS are mainly the water bodies reflecting accumulation of water along the river course due to one or the other reason along the main Satluj river course in the Upper Satluj sub basin on the extreme southeastern side downstream of the Mansarovar Lake and the Rakas Tal (i.e., lakes with 1ds 138 & 145) in the Tibetan Himalayan Region from where the Satluj originates.

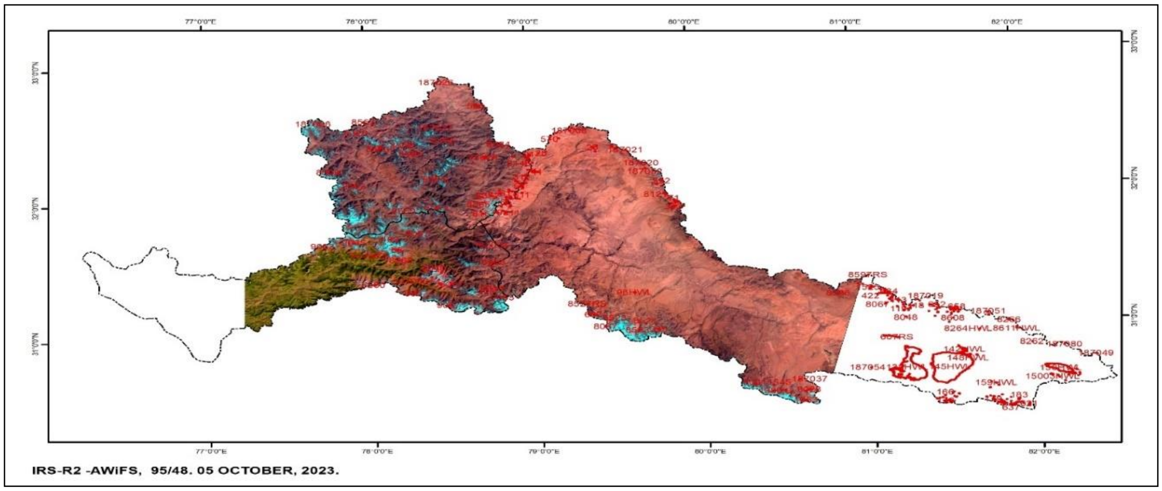


Fig. 6.7 (a): IRS-R2, AWiFS, 95/48, 05th October, 2023

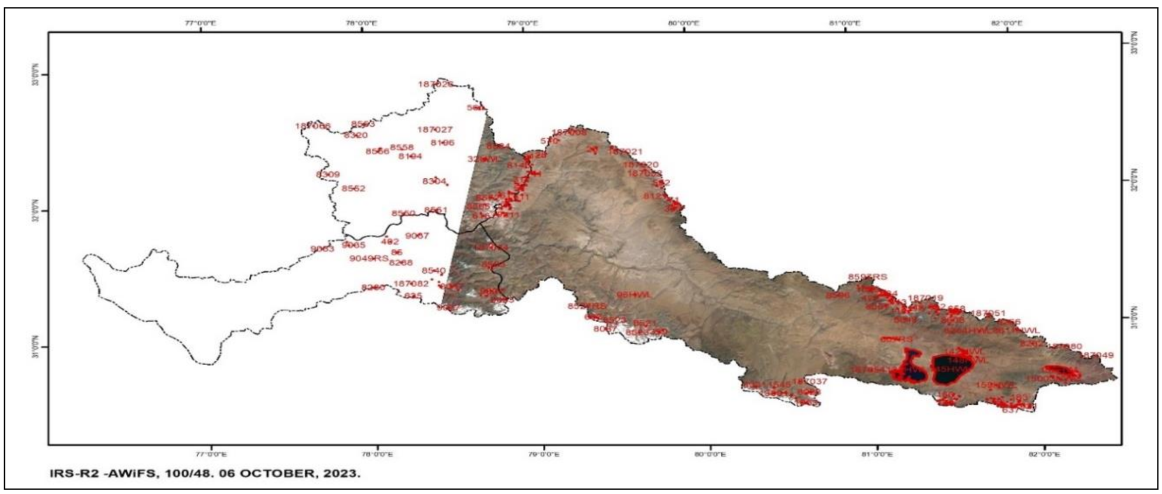


Fig. 6.7 (b): IRS-R2, AWiFS, 100/48, 6th October, 2023

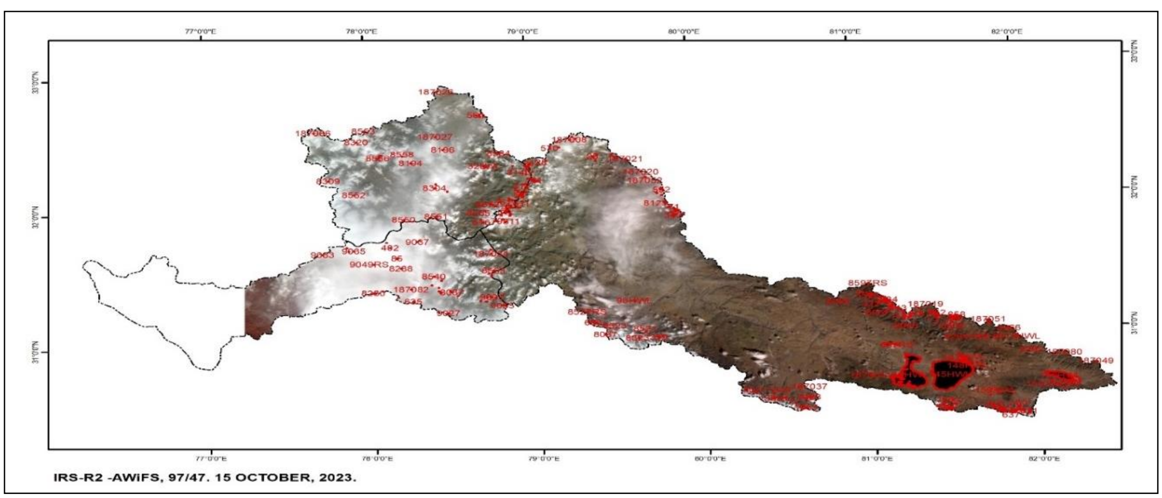


Fig. 6.7 (c): IRS-R2, AWiFS, 97/47, 15th October, 2023

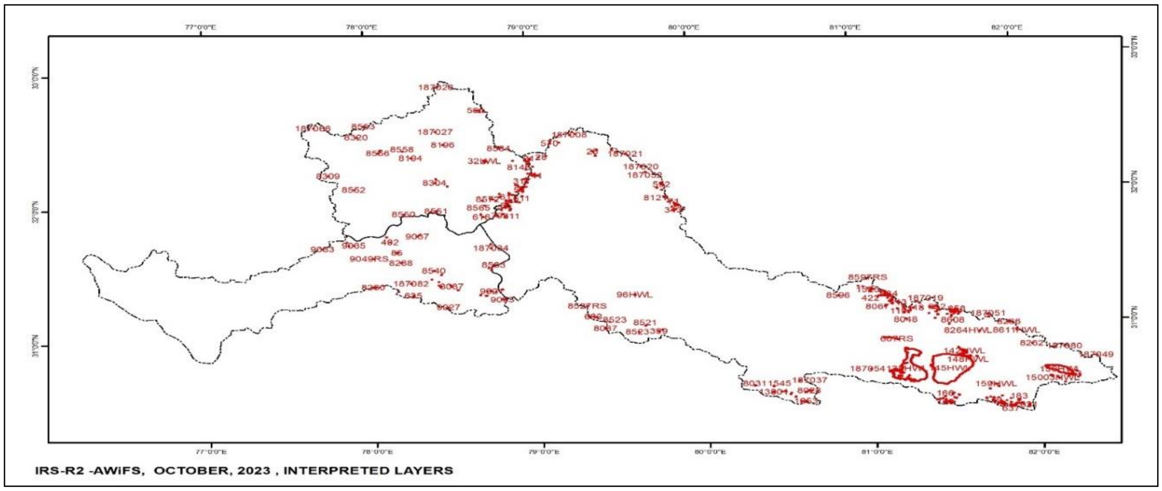


Fig. 6.7 (d): IRS-R2, AWiFS, October, 2023, Interpreted Layer

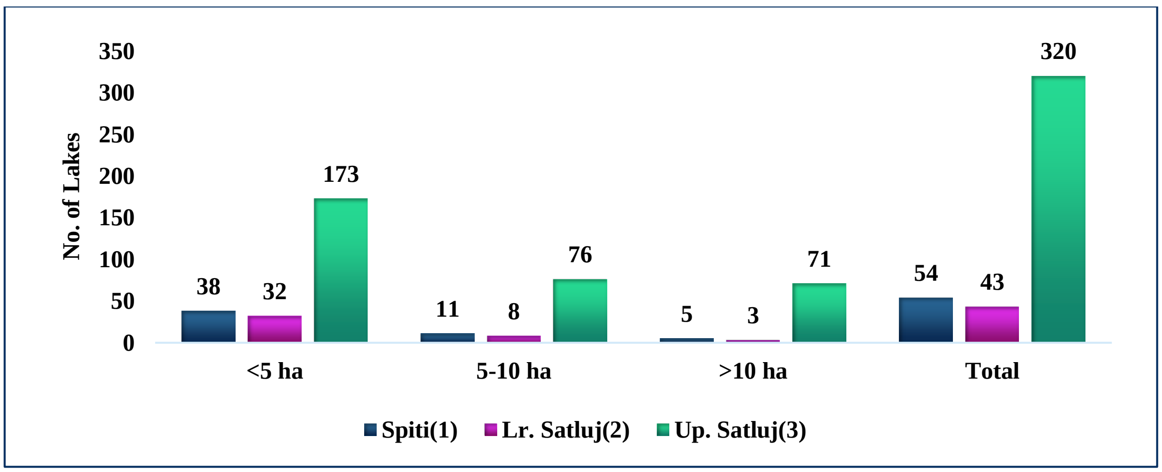


Fig. 6.7 (e): No. of Lakes based on IRS-R2, AWiFS, October, 2023

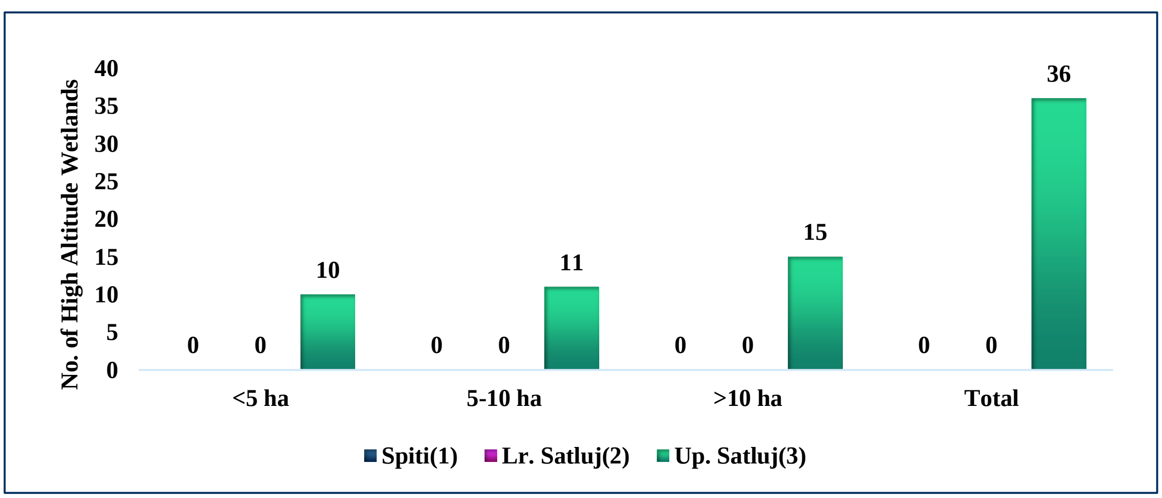


Fig. 6.7 (f): No. of High-altitude wetland Lakes based on IRS-R2, AWiFS, October, 2023

Table: 6.7 Aerial Extent of lakes as on October, 2023

S. No.	Lake Id.	Basin Number	Latitude	Longitude	Aerial Extent on Oct 2023 (Ha.)	Aerial Extent on Sept 2022 (Ha.)	Change in Area w.r.t. Sept. 2022 (Ha.)
1	23	3	32.39	79.42	10.03	13.65	(-)3.62
2	25	3	32.38	79.39	20.26	36.04	(-)15.78
3	28	3	32.35	79.06	6.38	7.89	(-)1.51
4	31	3	32.34	79.00	12.38	10.17	(+)2.21
5	39	3	32.23	79.03	8.50	9.36	(-)0.86
6	41	3	32.21	79.04	25.79	31.23	(-)5.44
7	51	3	32.12	78.94	4.79	7.23	(-)2.44
8	54	3	32.11	78.93	12.00	12.81	(-)0.81
9	55	3	32.11	78.94	9.73	12.05	(-)2.32
10	60	3	32.03	78.87	8.38	9.68	(-)1.31
11	61	1	32.03	78.85	19.09	23.61	(-)4.52
12	62	3	32.02	78.87	10.38	13.89	(-)3.51
13	63	3	32.02	78.88	2.98	3.90	(-)0.92
14	65	3	32.00	78.85	24.65	33.21	(-)8.56
15	71	3	31.98	79.87	8.96	13.20	(-)4.24
16	74	3	31.97	79.88	3.97	5.67	(-)1.70
17	79	3	31.92	78.78	21.20	23.52	(-)2.32
18	85	2	31.66	78.17	45.13	47.64	(-)2.51
19	106	3	31.24	81.10	6.09	6.29	(-)0.20
20	107	3	31.24	81.08	8.08	6.56	(+)1.51
21	112	3	31.20	81.15	13.25	17.43	(-)4.18
22	113	3	31.18	81.19	54.56	53.61	(+)0.95
23	114	3	31.18	81.15	25.79	30.50	(-)4.71
24	118	3	31.14	81.28	16.26	19.62	(-)3.36
25	119	3	31.13	81.23	6.07	7.90	(-)1.83
26	122	3	31.12	81.44	5.24	4.41	(+)0.84
27	166	3	30.47	81.43	8.56	6.03	(+)2.53
28	173	3	30.45	81.68	10.74	7.98	(+)2.76
29	178	3	30.43	81.43	229.39	229.97	(-)0.59
30	179	3	30.43	81.72	29.56	23.75	(+)5.81
31	183	3	30.43	81.87	27.68	24.78	(+)2.90
32	184	3	30.42	81.72	25.56	14.75	(+)10.80
33	196	3	30.39	81.90	10.99	12.86	(-)1.87
34	312	3	32.33	78.97	11.24	11.87	(-)0.63
35	313	3	32.32	78.98	11.14	12.65	(-)1.51
36	315	1	32.19	78.97	7.22	6.80	(+)0.42

37	**317**	**3**	**32.16**	**78.98**	**11.21**	**11.30**	(-)**0.09**
38	**319**	**3**	**31.98**	**78.84**	**16.97**	**18.56**	(-)**1.59**
39	**343**	**3**	**31.93**	**79.87**	**34.98**	**36.62**	(-)**1.64**
40	**399**	**3**	**31.03**	**79.73**	**11.05**	**16.33**	(-)**5.27**
41	402	2	31.74	78.12	2.95	3.47	(-)0.52
42	413	3	32.23	79.01	4.91	4.10	**(+)**0.80
43	414	1	32.26	78.98	2.67	3.33	(-)0.66
44	415	3	32.33	79.00	3.08	3.04	**(+)**0.04
45	416	3	32.45	79.19	4.39	4.21	**(+)**0.18
46	422	3	31.23	81.07	4.13	4.10	**(+)**0.03
47	**423**	**3**	**31.22**	**81.16**	**11.81**	**11.77**	**(+)0.03**
48	426	3	31.10	81.50	7.75	7.67	**(+)**0.08
49	427	3	31.14	81.38	9.39	9.49	(-)0.09
50	431	3	31.11	81.50	9.97	9.54	**(+)**0.44
51	432	3	31.08	81.52	4.01	3.53	**(+)**0.48
52	438	3	30.40	81.74	6.64	4.66	**(+)**1.98
53	439	3	30.43	81.72	5.44	4.61	**(+)**0.83
54	561	1	32.71	78.69	6.92	7.43	(-)0.51
55	562	3	32.28	79.02	3.37	3.37	-------
56	563	1	32.23	78.98	2.90	3.10	(-)0.20
57	570	3	32.45	79.13	6.35	6.05	**(+)**0.30
58	592	3	32.12	79.80	4.10	4.59	(-)0.49
59	607	3	31.25	81.13	4.33	5.32	(-)0.99
60	611	3	32.06	78.94	9.21	10.04	(-)0.83
61	616	1	31.91	78.70	6.26	9.23	(-)2.97
62	**621**	**3**	**30.39**	**81.93**	**95.25**	**92.63**	**(+)2.62**
63	622	3	31.27	81.09	3.02	3.30	(-)0.28
64	632	3	31.14	79.37	4.43	6.66	(-)2.23
65	**634**	**3**	**31.25**	**81.14**	**11.48**	**9.77**	**(+)1.71**
66	**635**	**2**	**31.34**	**78.25**	**15.71**	**25.13**	(-)**9.43**
67	636	3	31.27	81.11	3.90	4.39	(-)0.49
68	**637**	**3**	**30.39**	**81.84**	**16.66**	**10.62**	**(+)6.05**
69	638	3	30.39	81.84	7.00	1.97	**(+)**5.02
70	638	3	30.38	81.83	3.87	2.53	**(+)**1.33
71	641	3	31.96	79.89	4.83	3.81	**(+)**1.02
72	645	3	31.27	81.09	7.41	8.05	(-)0.65
73	646	3	31.27	81.12	1.52	1.72	(-)0.20
74	647	3	31.26	81.12	4.20	3.64	**(+)**0.55
75	648	3	31.24	81.12	4.15	4.19	(-)0.04
76	649	3	31.25	81.13	3.76	2.49	**(+)**1.27
77	651	3	31.13	81.40	6.66	7.97	(-)1.31
78	652	3	31.14	81.42	9.66	7.12	**(+)**2.54

79	655	3	31.10	81.51	7.77	7.22	**(+)**0.55
80	656	3	31.10	81.53	5.07	3.19	**(+)**1.88
81	657	3	31.11	81.55	6.71	5.84	**(+)**0.87
82	**658**	**3**	**31.12**	**81.54**	**12.10**	**11.17**	**(+)0.93**
83	663	3	31.15	79.34	6.90	6.14	**(+)**0.76
84	**688**	**3**	**30.41**	**81.82**	**10.81**	**10.39**	**(+)0.42**
85	**811**	**3**	**31.92**	**78.84**	**15.44**	**13.90**	**(+)1.53**
86	825	3	31.25	81.11	3.38	2.01	**(+)**1.37
87	827	3	31.20	81.14	7.60	10.60	(-)3.00
88	828	3	31.21	81.15	2.69	2.00	**(+)**0.69
89	840	3	30.40	81.79	6.12	3.69	**(+)**2.43
90	865	3	30.40	81.78	3.73	3.63	**(+)**0.09
91	870	1	32.13	78.93	1.65	1.37	**(+)**0.28
92	885	3	31.94	79.88	3.15	2.45	**(+)**0.70
93	888	3	31.21	81.15	1.70	1.72	(-)0.02
94	895	3	30.38	81.84	2.70	2.47	**(+)**0.23
95	964	3	30.41	81.77	2.74	2.54	**(+)**0.20
96	1030	3	31.19	81.18	2.22	3.20	(-)0.97
97	1038	3	32.13	79.80	4.92	4.97	(-)0.05
98	**1053**	**3**	**30.48**	**80.59**	**24.67**	**19.94**	**(+)4.72**
99	**1133**	**3**	**30.42**	**81.87**	**16.33**	**14.31**	**(+)2.03**
100	1142	3	30.41	81.78	1.36	2.74	(-)1.38
101	1149	3	30.40	81.77	8.55	7.15	**(+)**1.40
102	1155	3	31.99	79.84	2.48	3.52	(-)1.04
103	1510	3	31.10	81.56	3.77	2.28	**(+)**1.49
104	1511	3	31.09	81.43	3.66	4.66	(-)0.99
105	1512	3	31.08	81.42	3.05	3.46	(-)0.41
106	1515	3	31.10	81.42	4.10	5.27	(-)1.16
107	1516	3	31.15	81.41	2.67	2.74	(-)0.07
108	1519	3	31.17	81.22	3.39	2.40	**(+)**0.99
109	1522	3	31.17	81.12	3.30	3.29	**(+)**0.01
110	1524	3	31.29	81.03	6.22	5.98	**(+)**0.24
111	**1525**	**3**	**31.29**	**81.03**	**15.20**	**24.34**	(-)**9.14**
112	**1531**	**3**	**31.97**	**78.87**	**12.28**	**12.44**	(-)**0.15**
113	1532	3	31.96	78.87	5.61	4.28	**(+)**1.33
114	1543	3	30.46	81.39	4.83	3.77	**(+)**1.06
115	1545	3	30.60	80.40	6.03	7.97	(-)1.94
116	1568	3	32.01	78.85	2.73	2.72	**(+)**0.01
117	1585	1	32.09	78.86	2.95	2.94	**(+)**0.01
118	1606	3	32.23	79.00	9.06	1.68	**(+)**7.38
119	6021	3	31.13	81.26	3.29	1.35	**(+)**1.94
120	6060	3	31.93	78.82	1.75	1.75	**-------**

121	7004	3	31.93	78.82	2.55	2.54	**(+)**0.01
122	8005	3	30.39	81.83	1.11	1.10	**(+)**0.01
123	8008	3	30.40	81.78	0.90	1.51	(-)0.60
124	8011	3	30.48	80.57	6.27	5.64	**(+)**0.63
125	8024	3	30.54	80.51	2.49	2.76	(-)0.27
126	**8027**	**3**	**30.55**	**80.47**	**16.39**	**15.60**	**(+)0.79**
127	8028	3	32.17	78.97	2.66	2.60	**(+)**0.06
128	8028	3	30.55	80.62	8.36	8.31	**(+)**0.05
129	8029	3	30.55	80.63	3.98	3.95	**(+)**0.03
130	**8031**	**3**	**30.60**	**80.29**	**22.83**	**23.21**	(-)**0.38**
131	8037	3	31.06	79.41	5.56	6.65	(-)1.10
132	8038	3	31.06	79.42	4.96	7.84	(-)2.88
133	8048	3	31.06	81.23	4.38	6.79	(-)2.41
134	8052	3	31.08	81.55	4.49	4.03	**(+)**0.46
135	8053	3	31.09	81.55	1.38	2.63	(-)1.25
136	8054	3	31.09	81.53	3.60	3.68	(-)0.08
137	8056	3	31.11	81.41	1.95	2.58	(-)0.62
138	8057	3	31.12	81.26	4.78	5.27	(-)0.49
139	8058	3	31.12	81.42	2.05	2.03	**(+)**0.02
140	8062	3	31.14	81.18	4.29	4.36	(-)0.06
141	8063	3	31.14	81.26	2.03	2.84	(-)0.81
142	**8065**	**3**	**31.15**	**81.22**	**13.96**	**14.08**	(-)**0.12**
143	8067	3	31.16	81.11	3.79	4.12	(-)0.33
144	8071	2	31.30	78.80	1.21	2.71	(-)1.50
145	8074	3	31.22	81.13	4.20	5.77	(-)1.57
146	8076	3	31.23	81.15	2.26	1.15	**(+)**1.11
147	8077	2	31.33	78.70	3.04	4.91	(-)1.87
148	**8079**	**3**	**31.24**	**81.14**	**10.93**	**12.54**	(-)**1.61**
149	8083	3	31.28	81.03	2.33	2.43	(-)0.10
150	8086	3	31.30	81.01	4.09	4.82	(-)0.73
151	8087	2	31.40	78.49	5.21	7.96	(-)2.75
152	8088	3	31.32	80.95	2.70	2.98	(-)0.28
153	8101	1	31.94	78.69	1.33	1.33	------
154	8107	3	31.97	79.90	5.86	2.19	**(+)**3.67
155	8117	1	32.04	78.76	2.33	2.71	(-)0.38
156	8118	1	32.04	78.76	1.36	1.83	(-)0.47
157	8121	3	32.02	79.83	5.86	13.96	(-)8.10
158	**8123**	**3**	**32.07**	**78.89**	**11.15**	**2.99**	**(+)8.17**
159	8125	3	32.03	79.81	5.77	2.62	**(+)**3.16
160	**8127**	**1**	**32.06**	**78.81**	**11.10**	**11.07**	**(+)0.03**
161	8131	3	32.12	78.95	4.25	4.20	**(+)**0.05
162	8137	1	32.14	78.92	3.90	4.43	(-)0.53

163	8138	3	32.15	78.96	2.44	3.14	(-)0.70
164	8139	3	32.12	79.79	3.46	8.10	(-)4.63
165	8141	1	32.19	78.96	2.76	2.96	(-)0.20
166	8142	3	32.21	79.02	3.63	3.77	(-)0.13
167	8143	3	32.22	79.01	1.80	2.05	(-)0.25
168	**8146**	**3**	**32.30**	**78.98**	**14.12**	**18.62**	(-)**4.50**
169	8153	3	32.36	79.10	4.08	3.68	**(+)**0.40
170	8154	3	32.35	79.41	4.54	2.75	**(+)**1.79
171	8159	3	32.40	79.51	2.24	1.18	**(+)**1.06
172	8170	2	31.40	78.42	2.69	3.16	(-)0.47
173	8171	2	31.41	78.41	1.65	2.69	(-)1.04
174	8172	2	31.44	78.41	1.86	3.00	(-)1.15
175	8173	2	31.46	78.37	2.65	3.43	(-)0.78
176	**8194**	**1**	**32.36**	**78.27**	**12.33**	**13.97**	(-)**1.64**
177	8196	1	32.46	78.47	8.30	6.60	**(+)**1.69
178	8236	3	31.04	79.75	7.75	7.07	**(+)**0.69
179	**8249**	**3**	**30.40**	**81.85**	**25.12**	**25.98**	(-)**0.87**
180	8251	3	30.40	81.89	9.02	4.80	**(+)**4.22
181	8262	3	30.84	81.98	4.87	13.97	(-)9.10
182	**8266**	**3**	**31.01**	**81.85**	**30.64**	**7.07**	**(+)23.58**
183	8272	3	31.12	81.25	2.70	25.98	(-)23.29
184	8277	2	31.42	78.07	1.96	4.80	-2.84
185	8280	2	31.41	78.01	5.92	10.30	(-)4.38
186	8281	2	31.41	78.03	3.56	5.35	(-)1.79
187	8282	3	31.31	80.98	2.02	1.78	**(+)**0.24
188	8286	3	32.05	78.90	2.69	2.68	**(+)**0.01
189	8288	2	31.58	78.19	8.71	10.46	(-)1.76
190	8292	3	31.94	79.92	1.61	1.60	**(+)**0.01
191	8293	3	31.95	79.86	1.68	1.77	(-)0.09
192	8295	1	32.04	78.70	2.41	2.40	**(+)**0.01
193	8296	3	32.02	79.82	2.39	4.86	(-)2.47
194	8299	3	32.13	78.95	3.26	1.84	**(+)**1.42
195	**8304**	**1**	**32.18**	**78.41**	**10.18**	**10.20**	(-)**0.02**
196	8307	1	32.20	78.42	5.20	5.68	(-)0.49
197	8309	1	32.24	77.76	4.16	4.77	(-)0.60
198	8320	1	32.52	77.94	4.57	6.88	(-)2.30
199	8506	3	30.39	81.78	1.79	1.78	**(+)**0.01
200	8507	3	30.40	81.78	1.21	1.16	**(+)**0.05
201	8508	3	30.40	81.78	2.17	2.09	**(+)**0.08
202	8509	3	30.40	81.76	1.19	1.18	**(+)**0.01
203	8514	3	30.46	81.41	3.24	2.76	**(+)**0.48
204	**8517**	**3**	**30.51**	**80.53**	**12.30**	**11.76**	**(+)0.54**

205	8518	3	30.53	80.50	4.15	3.59	**(+)**0.56
206	8520	3	31.08	79.65	2.00	2.00	(-)0.01
207	8521	3	31.07	79.65	2.34	2.66	(-)0.32
208	8523	3	31.11	79.44	2.26	2.25	**(+)**0.01
209	8523	3	31.03	79.61	2.88	2.96	(-)0.09
210	8524	3	31.15	79.36	2.35	2.82	(-)0.48
211	8525	3	31.16	79.32	1.26	1.25	**(+)**0.01
212	8531	2	31.37	78.72	2.77	4.59	(-)1.82
213	8532	2	31.36	78.70	2.71	2.45	**(+)**0.27
214	8538	2	31.49	78.43	2.98	4.84	(-)1.85
215	8540	2	31.52	78.38	7.28	9.86	(-)2.58
216	8541	2	31.37	78.16	2.45	2.89	(-)0.44
217	8545	2	31.78	78.10	1.31	3.56	(-)2.25
218	8546	2	31.78	78.10	2.32	4.04	(-)1.73
219	8549	1	31.79	78.31	1.73	4.01	(-)2.29
220	8550	1	31.95	78.22	1.33	3.46	(-)2.13
221	8551	1	31.96	78.42	8.79	9.97	(-)1.18
222	8552	1	32.14	77.91	1.55	4.25	(-)2.70
223	8553	1	32.61	77.99	5.24	5.77	(-)0.53
224	8554	1	32.43	78.09	1.02	3.51	(-)2.49
225	8555	1	32.42	78.08	4.18	4.95	(-)0.77
226	8556	1	32.40	78.07	4.88	4.35	**(+)**0.53
227	8557	1	32.40	78.07	2.45	2.35	**(+)**0.10
228	8558	1	32.42	78.22	2.65	3.46	(-)0.81
229	8561	2	31.53	78.72	1.87	3.57	(-)1.70
230	8562	2	31.52	78.74	4.12	6.74	(-)2.63
231	8563	2	31.56	78.75	7.73	5.58	**(+)**2.15
232	8565	1	32.00	78.71	1.86	1.86	**(+)**0.00
233	8566	3	31.93	78.82	1.14	1.14	**(+)**0.00
234	8567	3	31.97	78.81	6.13	6.11	**(+)**0.02
235	8568	3	31.97	78.80	1.33	1.37	(-)0.04
236	8571	1	32.03	78.78	1.46	1.45	**(+)**0.00
237	8572	1	32.04	78.76	2.41	3.24	(-)0.83
238	8573	1	32.08	78.80	1.51	1.86	(-)0.35
239	8574	1	32.07	78.86	1.29	1.29	-------
240	8575	3	32.02	78.91	5.79	2.38	**(+)**3.41
241	8576	3	32.12	78.95	2.15	2.45	(-)0.29
242	8577	1	32.15	78.91	2.17	1.91	**(+)**0.26
243	8580	3	32.32	78.99	1.52	4.40	(-)2.87
244	8581	1	32.33	78.90	2.49	3.24	(-)0.75
245	8584	1	32.42	78.82	8.42	11.73	(-)3.31
246	8588	3	32.39	79.51	1.99	2.85	(-)0.87

247	8590	3	32.13	79.80	4.98	4.96	**(+)**0.02
248	8596	3	31.25	80.83	6.15	6.37	(-)0.22
249	8598	3	31.28	81.02	1.68	1.49	**(+)**0.19
250	8599	3	31.29	81.05	1.17	2.34	(-)1.17
251	8600	3	31.24	81.11	2.18	2.42	(-)0.24
252	8602	3	31.09	81.37	2.99	2.97	**(+)**0.02
253	8603	3	31.06	81.41	3.93	3.89	**(+)**0.03
254	8604	3	31.08	81.48	4.36	3.71	**(+)**0.65
255	8606	3	31.01	81.49	2.63	3.04	(-)0.42
256	8608	3	31.04	81.51	5.05	4.97	**(+)**0.09
257	8609	3	31.10	81.55	2.08	2.51	(-)0.43
258	8616	2	31.71	78.74	2.98	4.14	(-)1.15
259	8654	2	31.72	77.87	4.57	4.35	**(+)**0.23
260	9000	3	31.27	81.09	1.53	1.39	**(+)**0.14
261	9001	3	31.24	81.09	2.03	2.62	(-)0.59
262	9002	3	31.11	81.25	1.64	1.62	**(+)**0.01
263	9004	3	31.07	81.51	1.89	1.83	**(+)**0.06
264	9005	3	31.07	81.50	1.12	1.11	**(+)**0.01
265	9006	3	31.11	81.52	3.76	3.85	(-)0.09
266	9007	3	31.12	81.54	5.86	4.05	**(+)**1.81
267	9015	3	30.45	81.38	8.31	8.24	**(+)**0.07
268	9016	3	30.46	81.41	1.72	4.04	(-)2.32
269	9017	3	30.55	80.45	3.90	4.37	(-)0.47
270	9020	2	31.36	78.76	2.25	5.48	(-)3.23
271	9021	2	31.36	78.73	4.37	4.03	**(+)**0.34
272	9025	2	31.34	78.66	2.69	3.02	(-)0.33
273	9026	2	31.33	78.66	2.47	3.16	(-)0.69
274	9027	2	31.25	78.46	4.73	10.79	(-)6.05
275	9030	2	31.37	78.53	2.55	2.54	**(+)**0.01
276	9031	2	31.41	78.48	3.00	3.93	(-)0.93
277	9032	2	31.40	78.42	3.69	5.26	(-)1.57
278	9033	2	31.70	77.71	4.87	5.96	(-)1.09
279	9034	2	31.75	77.86	3.28	3.27	**(+)**0.01
280	9035	2	31.72	77.90	8.35	7.54	**(+)**0.80
281	9037	2	31.78	78.29	2.20	3.88	(-)1.69
282	9040	1	32.10	78.91	2.26	2.25	**(+)**0.01
283	9041	1	32.08	78.87	4.06	4.19	(-)0.13
284	9043	3	32.02	78.93	3.13	3.91	(-)0.78
285	9045	1	32.01	78.85	1.98	1.98	**(+)**0.01
286	9052	2	31.33	78.70	3.25	4.63	(-)1.38
287	9053	2	31.30	78.80	2.30	4.49	(-)2.19
288	9056	3	31.15	81.22	4.03	3.40	**(+)**0.63

289	9058	3	31.97	79.88	4.62	8.48	(-)3.86
290	9059	3	31.96	79.88	4.98	3.77	**(+)**1.21
291	9060	3	31.97	79.88	3.52	4.15	(-)0.63
292	9062	3	31.99	79.85	5.66	6.17	(-)0.51
293	**13801**	**3**	**30.55**	**80.40**	**41.84**	**44.02**	(-)**2.18**
294	18701	3	30.39	81.85	4.93	4.01	**(+)**0.91
295	**185001**	**3**	**30.41**	**81.75**	**10.75**	**11.50**	(-)**0.75**
296	187004	3	30.40	81.79	7.42	7.35	**(+)**0.07
297	187005	3	32.37	79.53	2.45	--------	--------
298	187006	3	32.47	79.13	3.52	--------	--------
299	187007	3	32.49	79.17	3.20	--------	--------
300	187008	3	32.51	79.25	5.07	--------	--------
301	187009	3	32.53	79.27	1.33	--------	--------
302	187010	3	32.52	79.29	2.41	--------	--------
303	187011	3	32.08	79.80	5.96	--------	--------
304	187012	1	32.03	78.87	7.17	--------	--------
305	**187013**	**3**	**31.24**	**81.11**	**17.35**	**--------**	**--------**
306	187014	3	30.92	81.14	4.71	--------	--------
307	187015	3	30.79	81.57	1.73	--------	--------
308	**187016**	**3**	**30.76**	**81.64**	**23.15**	**--------**	**--------**
309	187017	3	30.40	81.87	9.71	--------	--------
310	187018	3	31.17	81.32	1.47	--------	--------
311	187019	3	31.18	81.30	3.98	--------	--------
312	187020	3	32.26	79.68	7.55	--------	--------
313	187021	3	32.36	79.59	8.63	--------	--------
314	187022	3	32.36	79.59	5.79	--------	--------
315	187023	1	32.70	78.71	2.58	--------	--------
316	187024	1	32.70	78.73	2.08	--------	--------
317	187025	1	32.71	78.71	4.11	--------	--------
318	187026	1	32.89	78.45	8.40	--------	--------
319	187027	1	32.55	78.43	2.53	--------	--------
320	187028	1	32.15	78.49	5.52	--------	--------
321	187029	1	32.05	78.75	1.21	--------	--------
322	187030	1	32.05	78.75	1.11	--------	--------
323	187031	1	32.05	78.76	2.24	--------	--------
324	187034	2	31.68	78.74	7.34	--------	--------
325	187035	3	32.13	78.96	6.91	--------	--------
326	**187036**	**3**	**30.54**	**80.60**	**10.95**	**--------**	**--------**
327	187037	3	30.63	80.56	5.01	--------	--------
328	187038	3	30.45	81.43	7.39	--------	--------
329	187039	3	30.43	81.48	1.60	--------	--------
330	187040	3	30.43	81.48	1.75	--------	--------

331	187041	3	30.46	81.50	2.26	--------	--------
332	187042	3	30.46	81.48	2.42	--------	--------
333	187043	3	30.46	81.49	1.84	--------	--------
334	187044	3	30.48	81.48	2.25	--------	--------
335	187045	3	30.49	81.48	2.34	--------	--------
336	187046	3	30.48	81.51	4.25	--------	--------
337	**187047**	**3**	**30.48**	**81.51**	**10.92**	**--------**	**--------**
338	187048	3	30.50	81.48	2.71	--------	--------
339	187049	3	30.73	82.36	2.69	--------	--------
340	187050	3	31.07	81.72	8.65	--------	--------
341	**187051**	**3**	**31.05**	**81.73**	**20.36**	**--------**	**--------**
342	187052	3	32.22	79.71	3.15	--------	--------
343	187053	3	32.10	78.95	6.34	--------	--------
344	187054	3	30.70	81.00	5.71	--------	--------
345	187055	3	32.13	78.97	4.84	--------	--------
346	187056	3	31.14	81.33	1.88	--------	--------
347	**187059**	**3**	**30.39**	**81.82**	**19.34**	**--------**	**--------**
348	187060	3	30.43	81.80	2.23	--------	--------
349	187061	3	30.40	81.79	2.94	--------	--------
350	187062	3	32.10	79.77	4.41	--------	--------
351	187066	1	32.60	77.68	2.66	--------	--------
352	187066	3	30.44	81.46	4.83	--------	--------
353	**187068**	**3**	**30.43**	**81.46**	**17.26**	**--------**	**--------**
354	187069	3	30.43	81.47	2.19	--------	--------
355	187070	3	30.60	82.25	2.12	--------	--------
356	187071	3	30.60	82.25	1.83	--------	--------
357	187072	3	30.59	82.25	0.84	--------	--------
358	187073	3	30.58	82.24	3.16	--------	--------
359	187074	3	30.60	82.22	8.69	--------	--------
360	187075	3	30.60	82.22	2.27	--------	--------
361	187076	3	30.59	82.22	2.73	--------	--------
362	187077	3	30.62	82.23	1.49	--------	--------
363	187078	3	30.62	82.24	1.38	--------	--------
364	187079	3	30.63	82.23	2.14	--------	--------
365	187080	3	30.81	82.17	2.71	--------	--------
366	187081	3	31.94	78.82	5.59	--------	--------
367	**187082**	**2**	**31.43**	**78.24**	**13.13**	--------	--------
368	1012HWL	3	30.82	81.54	2.80	2.13	**(+)**0.67
369	1022RS	3	30.93	81.11	2.47	2.39	**(+)**0.09
370	1101HWL	3	30.45	81.75	2.88	2.63	**(+)**0.26
371	1124HWL	3	30.44	81.82	5.01	3.54	**(+)**1.47
372	1136HWL	3	30.41	81.78	9.21	5.92	**(+)**3.29

373	138HWL	3	30.69	81.23	25613.90	25806.38	-192.48
374	142HWL	3	30.80	81.57	357.20	337.86	(+)19.34
375	145HWL	3	30.69	81.47	42026.60	41698.35	(+)328.25
376	148HWL	3	30.76	81.59	138.66	123.59	(+)15.07
377	15002HWL	3	30.60	82.07	18.40	43.66	(-)25.26
378	15003HWL	3	30.59	82.08	23.00	5.30	(+)17.70
379	150HWL	3	30.64	82.14	6067.26	5974.58	(+)92.68
380	159HWL	3	30.55	81.74	16.83	15.60	(+)1.23
381	205HWL	3	30.79	81.57	6.70	5.56	(+)1.14
382	206HWL	3	30.79	81.55	4.44	6.83	(-)2.39
383	210HWL	3	30.77	81.55	54.00	60.24	(-)6.24
384	211HWL	3	30.77	81.57	10.79	9.76	(+)1.03
385	211HWL	3	30.52	81.70	13.68	10.80	(+)2.88
386	32LWL	1	32.33	78.73	116.38	109.62	(+)6.75
387	385HWL	3	30.78	81.54	5.00	3.54	(+)1.46
388	440HWL	3	30.45	81.72	10.76	9.29	(+)1.47
389	441HWL	3	30.46	81.70	3.92	3.30	(+)0.63
390	607RS	3	30.91	81.17	69.31	76.41	(-)7.10
391	608RS	3	30.93	81.09	19.99	14.36	(+)5.64
392	608RS	3	30.93	81.10	8.77	4.44	(+)4.33
393	616RS	3	30.93	81.12	13.69	11.76	(+)1.93
394	8055SG	3	31.11	81.22	5.36	5.54	(-)0.18
395	824HWL	3	30.42	81.76	5.95	4.83	(+)1.12
396	8258HWL	3	30.56	81.71	7.63	7.66	(-)0.03
397	8263RS	3	30.93	81.11	2.72	1.74	(+)0.99
398	8264HWL	3	30.95	81.67	4.07	3.09	(+)0.98
399	8500HWL	3	30.57	82.12	2.61	1.86	(+)0.74
400	8501HWL	3	30.54	82.16	5.41	4.85	(+)0.56
401	8502HWL	3	30.59	82.18	3.92	2.67	(+)1.25
402	8510RS	3	30.46	81.77	4.43	3.85	(+)0.57
403	8511HWL	3	30.53	81.76	15.77	13.64	(+)2.12
404	8515HWL	3	30.71	81.36	72.81	35.98	(+)36.83
405	8516RS	3	30.92	81.13	4.66	4.62	(+)0.04
406	8527RS	3	31.23	79.31	5.46	4.65	(+)0.81
407	8528RS	3	31.37	78.80	2.10	2.80	(-)0.70
408	8597RS	3	31.38	81.02	1.79	2.31	(-)0.52
409	8610HWL	3	30.96	81.89	6.77	6.66	(+)0.11
410	8611HWL	3	30.95	81.89	7.51	7.19	(+)0.32
411	9010HWL	3	30.83	81.53	5.19	8.60	(-)3.41
412	9012HWL	3	30.78	81.53	2.30	2.82	(-)0.52
413	9013HWL	3	30.59	82.12	2.51	2.29	(+)0.22
414	9014HWL	3	30.41	81.78	3.35	5.18	(-)1.83

415	9049RS	2	31.62	78.02	5.02	6.06	(-)1.03
416	9065HWL	3	30.78	81.56	9.04	9.52	(-)0.48
417	**96HWL**	**3**	**31.31**	**79.60**	**32.63**	**59.81**	**(-)27.18**

HWL- High Altitude Wetlands
RS- River Section
LWL-Landslide Induced Lake

6.8: STATUS OF LAKES AS ON NOVEMBER 2023

During, November 2023 only three scenes for the period 13th November had been procured which also reflects some snow cover impacts. (Fig: 6.8 (a)-(b)) as a result of which only 36 lakes were delineated (Fig: 6.8 (c)). Further, analysis of these 36 lakes reveals that 16 lakes forms part of Spiti sub basin, 3 from the Lower Satluj basin and 17 lakes form part of the Upper Satluj basin i.e., sub basin number 3. Further, analysis reveals that 11 lakes are small one with area less than 5 ha, 9 with area 5-10 ha and 16 are the big one with area more than 10 ha respectively (Fig: 6.8 (g)). When these 36 lakes were seen from its source point of view, it was found that 09 lakes out of 36 were mainly the high-altitude wetlands comprising 1 with area less than 5 ha, 8 with area more than 10 ha and all forms part of the lies in Upper Satluj sub basin (Fig: 6.8 (h)). Further, analysis reveals that out of 36 lakes, 10 lakes were such that they are formed along the river course by virtue of damming of the water due to one or the other reason (Table: 6.8). Further, these 36 lakes /wetlands were seen temporally w.r.t. 2022, it was found that only 28 lakes/wetlands could be compared of out of which 13 lakes/wetlands were characterized by reduction in their water spread, whereas 15 lakes/wetlands showed an increase in their water spread w.r.t. 2022, and the remaining which could not be compared forms the base line data for the next ablation season.

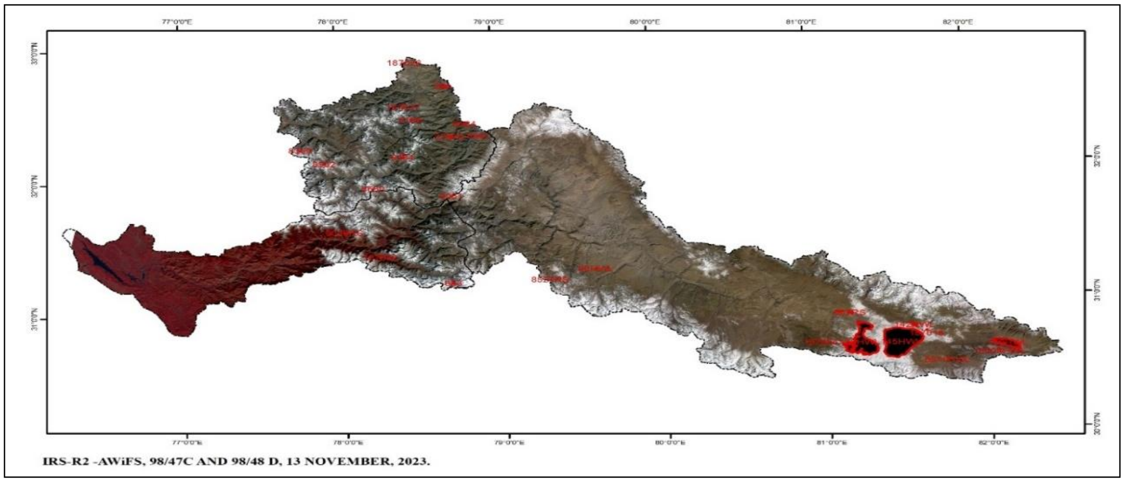


Fig. 6.8 (a): IRS, R2, AWiFS, 98/47 C and 98/48 D, 13th November, 2023

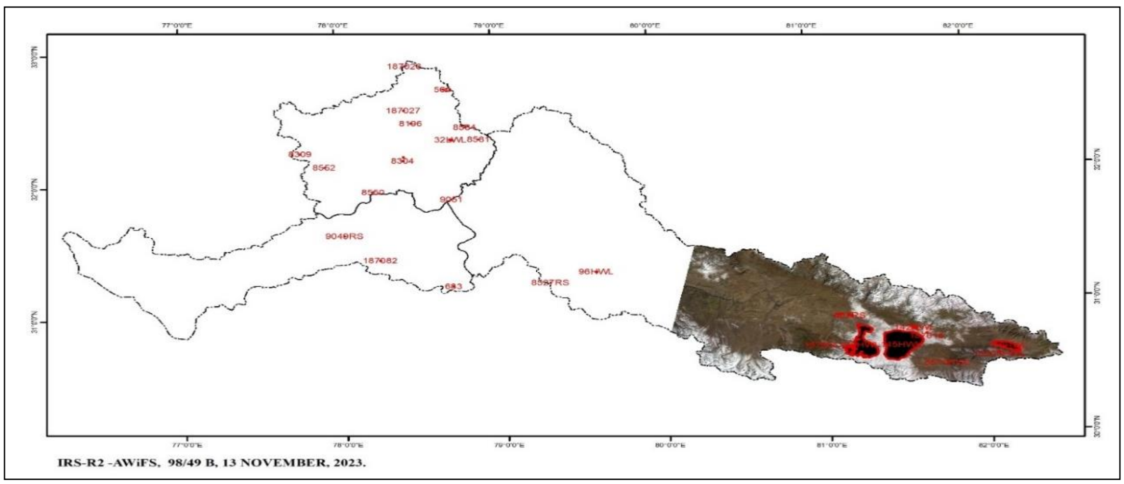


Fig. 6.8 (e): IR, R2-AWiFS, 98/49 B, 13th November, 2023, Interpreted Layers

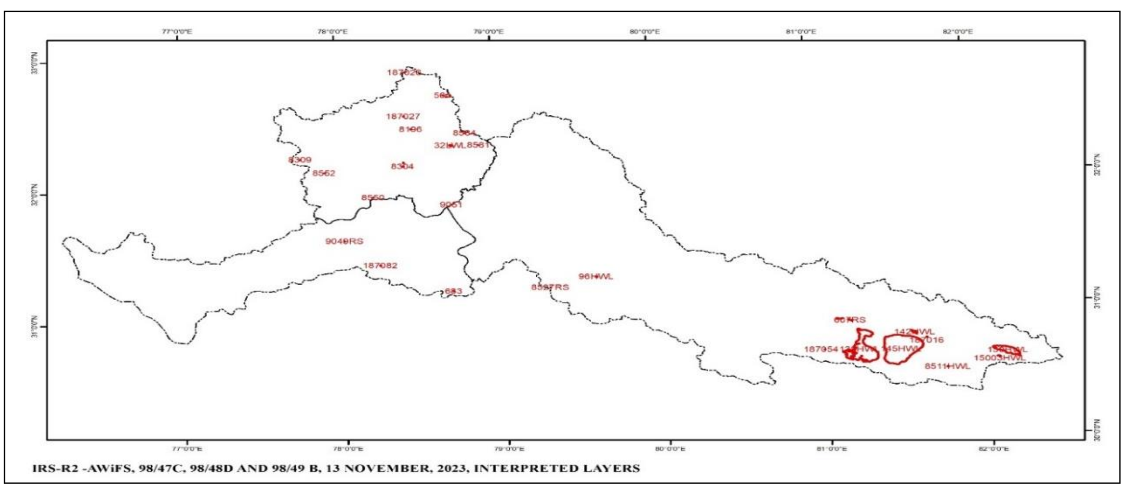


Fig. 6.8 (f): IR, R2-AWiFS, 13th November, 2023, Interpreted Layers

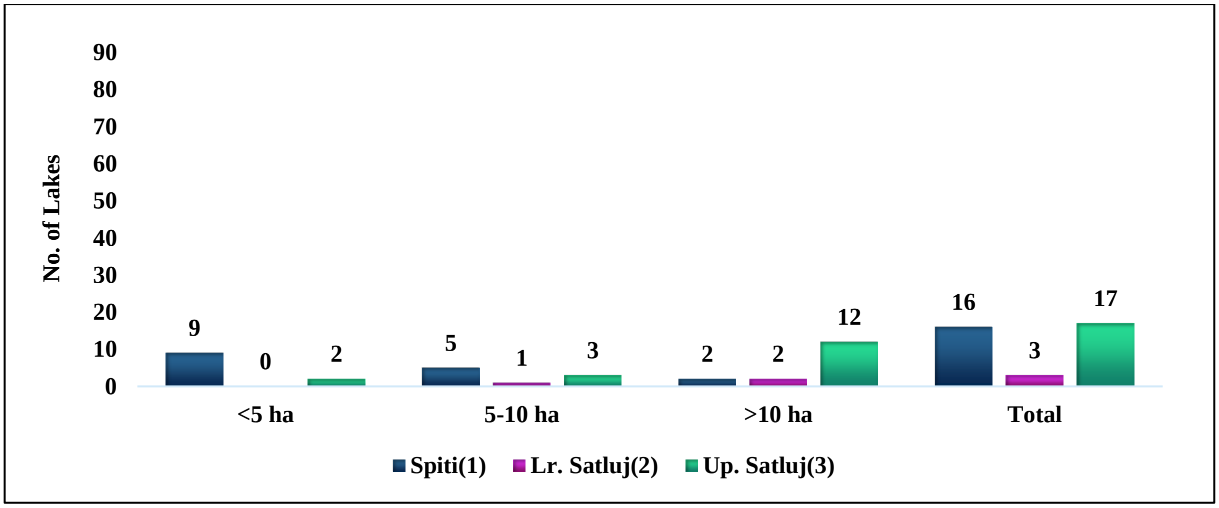


Fig. 6.8 (g): No. of Lakes based on IRS, R2-AWiFS, November, 2023.

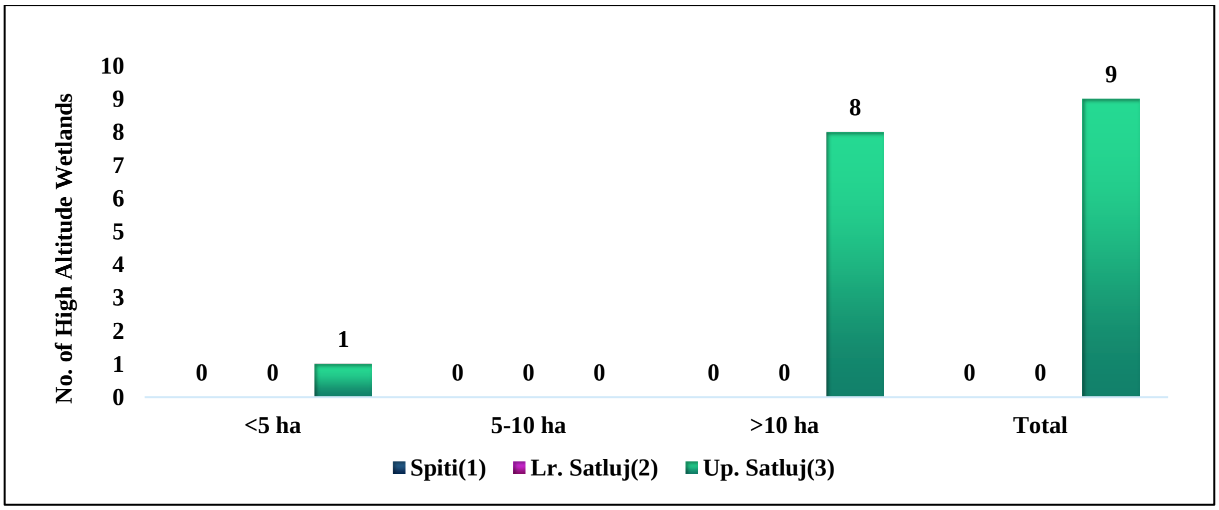


Fig.6.8 (h): No. of High-Altitude Wetland Lakes based on IRS, R2-AWiFS, November, 2023

Table: 6.8 Aerial Extent of lakes as on November, 2023

S. No.	Lake Id.	Basin Number	Latitude	Longitude	Aerial Extent on Nov 2023 (Ha.)	Aerial Extent on Sept 2022 (Ha.)	Change in Area w.r.t. Sept. 2022 (ha.)
1	561	1	32.71	78.69	6.92	7.43	(-)0.51
2	**683**	**2**	**31.22**	**78.70**	**11.03**	**13.27**	(-)**2.24**
3	8196	1	32.46	78.47	8.86	6.60	**(+)**2.26
4	**8304**	**1**	**32.18**	**78.41**	**11.06**	**10.20**	**(+)0.86**
5	8307	1	32.20	78.42	5.69	5.68	**(+)**0.01
6	8309	1	32.24	77.76	4.47	4.77	(-)0.30

7	8550	1	31.95	78.22	1.33	3.46	(-)2.13
8	8552	1	32.14	77.91	3.38	4.25	(-)0.87
9	8581	1	32.33	78.90	2.56	3.24	(-)0.68
10	8584	1	32.42	78.82	8.42	11.73	(-)3.31
11	9051	1	31.88	78.71	1.40	1.40	----------
12	**187016**	**3**	**30.76**	**81.64**	**19.42**	**--------**	**--------**
13	187023	1	32.70	78.71	2.58	--------	--------
14	187024	1	32.70	78.73	2.08	--------	--------
15	187025	1	32.71	78.71	4.11	--------	--------
16	187026	1	32.89	78.45	8.40	--------	--------
17	187027	1	32.56	78.43	2.53	--------	--------
18	187054	3	30.70	81.00	5.71	--------	--------
19	**187082**	**2**	**31.43**	**14.45**	**10.98**	**--------**	**--------**
20	1012HWL	3	30.82	81.54	2.80	2.13	(+)0.67
21	1022RS	3	30.92	81.11	2.47	2.39	(+)0.09
22	**138HWL**	**3**	**30.69**	**81.23**	**25433.14**	**25806.38**	(-)**373.24**
23	**142HWL**	**3**	**30.80**	**81.57**	**341.59**	**337.86**	**(+)3.73**
24	**145HWL**	**3**	**30.68**	**81.47**	**41631.18**	**41698.35**	(-)**67.17**
25	**15002HWL**	**3**	**30.60**	**82.07**	**20.70**	**43.66**	(-)**22.96**
26	**15003HWL**	**3**	**30.59**	**82.08**	**22.60**	**5.30**	**(+)17.30**
27	**150HWL**	**3**	**30.64**	**82.13**	**6067.26**	**5974.58**	**(+)92.68**
28	**32LWL**	**1**	**32.33**	**78.72**	**103.83**	**109.62**	(-)**5.79**
29	**607RS**	**3**	**30.91**	**81.17**	**77.20**	**76.41**	**(+)0.80**
30	**608RS**	**3**	**30.93**	**81.09**	**19.99**	**14.36**	**(+)5.64**
31	608RS	3	30.93	81.10	8.77	4.44	(+)4.33
32	**616RS**	**3**	**30.92**	**81.11**	**13.69**	**11.76**	**(+)1.93**
33	**8511HWL**	**3**	**30.53**	**81.75**	**15.66**	**13.64**	**(+)2.02**
34	8527RS	3	31.23	79.31	5.46	4.65	(+)0.81
35	9049RS	2	31.62	78.02	5.02	5.18	(-)0.16
36	**96HWL**	**3**	**31.31**	**79.60**	**36.94**	**59.81**	(-)**22.87**

7. INVENTORY OF LAKES BASED ON LISS III SATELLITE DATA FOR 2023:

Using IRS LISS-III Resourcesat 2/2A satellite data products having spatial resolution of 23.5 mts., a detailed inventory of glacial lakes/high altitude wetlands in the Satluj catchment was generated and the results thus obtained were compared with that of the result obtained during 2022. The inventory based on LISS-III satellite data is more detailed one as this sensor has the better spatial resolution (23.5 mts.) than AWiFS (56 mts.) and thus gives more information about the terrain. Satellite data for the month of July to October 2023 was browsed and good quality cloud free data was selected for the mapping purpose as during this period the glacier surfaces are completely exposed and liable to give more detailed information about the glacier regions. During the year 2023, good quality data could not obtain by virtue of the area under the impact of snow cover for a longer period and the thereafter the cloud cover during the monsoon season. The study area is covered by LISS-III coverage mainly by seven numbers of scenes within 96/48, 96/49, 97/48, 98/48,98/49, 99/49, 100/49 path and rows and these data products were analysed using visual interpretation techniques and the same methodology adopted for the AWIFS satellite data. As far as data availability is concerned, an attempt has been made to get the best quality data products during August/September 2023, but still in parts the impacts of cloud cover or snow cover could be seen. The study area covered under path-row 96/48 and 96/49 covering mainly the basin 1 & 2 i.e., Spiti and Lower Satluj basins for the period August, September and October LISS III images (Fig: 7.2 (a)) is a good quality data without any cloud cover and snow cover as a result of which maximum information of the catchment was retrieved. Likewise, under path row 97/48 & 97/49 (Fig: 7.3 (a)) LISS III were also of comparatively good quality leading to have complete information. Further on the extreme eastern part of the study area which is covered by 99/49 & 100/49 (Fig: 7.4 (a)) were also of the good quality and thus maximum information extracted from the best quality image products for 2023. Thus, based on visual interpretation techniques using above mentioned LISS III satellite data products for the above-mentioned paths -rows, a total of 1048 lakes and wetlands were delineated in 2023 in the study area, comprising 185 from Spiti basin, 182 from Lower Satluj basin, and 681 from Upper Satluj basin respectively in comparison to the total number of lakes delineated in 2022 (995) 2021 (880), 2020 (993), 2019 (562), and 2018 (769) (Fig: 7.1). The difference in the total number of lakes varies mainly due to the non-availability of good-quality snow-free and cloud-free data coverage during that particular year.

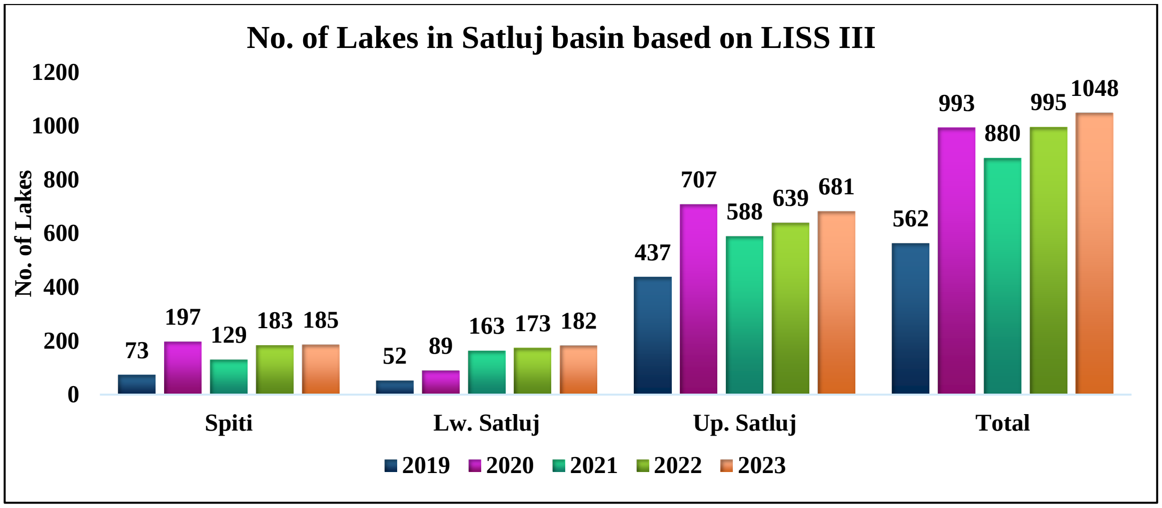


Fig. 7.1: No of lakes based on LISS III in Satluj Basin

Further detailed analysis for 2023 using LISS III analysis found that in the area covered under path rows 96/48 and 96/49, a total of 482 lakes (Fig: 7.2(a) & (b)) predominantly covering the areas from basins 1 and 2 were delineated in comparison to 478 (2022), 384 lakes (2021), 362 lakes (2020), 153 lakes (2019), and 275 lakes (2018) respectively. Further analysing the 482 lakes, it is found that 185 lakes forms part of the Spiti basin, i.e., basin 1, 182 forms part of the Lower Satluj basin, i.e., basin 2, and 115 form part of the Upper Satluj basin, i.e., basin 3. Further analysis reveals the majority of the lakes (438) have been classified as small ones with an area less than 5 ha, out of which 167 form part of the Spiti sub basin, 173 from the Lower Satluj, and 98from the Upper Satluj sub basin respectively. Likewise, 31 lakes are within the aerial range of 5–10 ha, out of which 12 lakes are in Spiti, 7 lakes are in the Lower Satluj, and 12 are in the Upper Satluj sub basin. Likewise, 13 lakes are the big one with area greater than 10 ha, out of which 6lakes are in Spiti, 2 lakes are in the Lower Satluj, and 5 lakes are in the Upper Satluj sub basin respectively (Fig. 7.2(c)). Further analysis based on their origin it is found that , only 4 lakes out of 482 are high-altitude wetland lakes comprising 1 from the Spiti sub basin and 3 from the Lower Satluj basin having an aerial extent of less than 5 hectares (Fig. 7.2(d)).The temporal analysis of the 482 lakes delineated from LISS III satellite images for 2023 with respect to 2022 suggest that 378 lakes /wetlands have shown an increase in their water spread w.r.t. 2022, whereas 80 lake/wetlands have shown a reduction in its area w.r.t 2022.The lakes /wetlands which could not be seen temporally forms the base line data for next year ablation as either these were not formed during 2022 due to one or the other reason or are the new one and mapped during 2023 (Table 7.1).

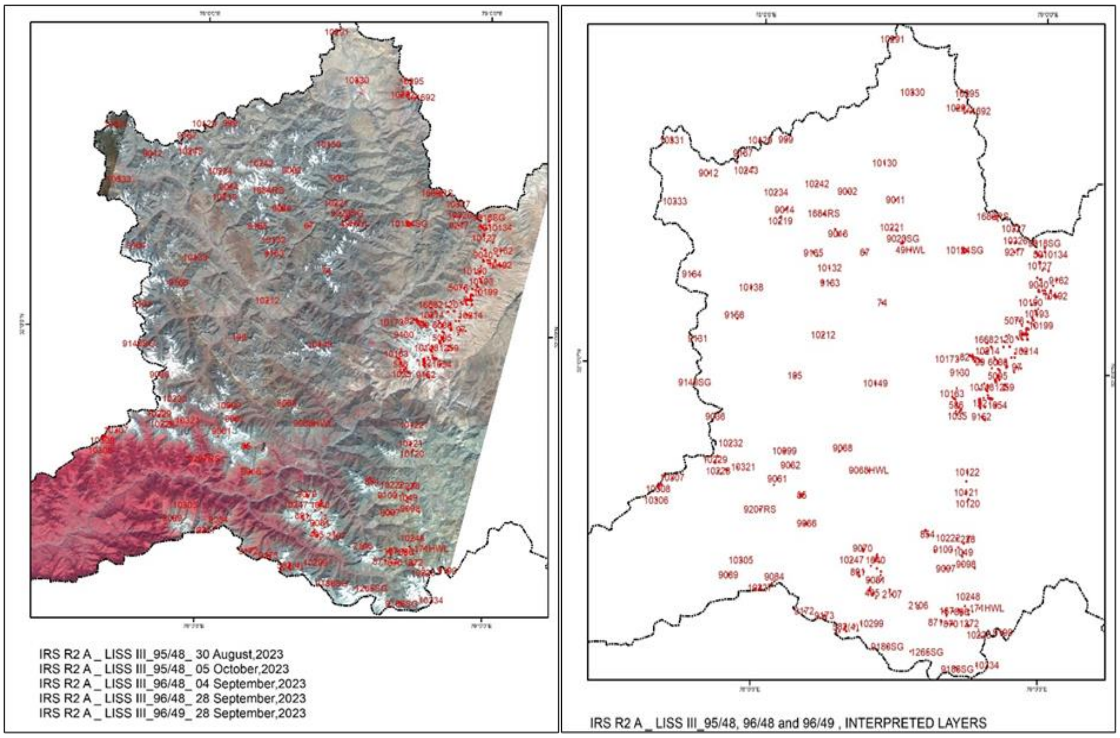


Fig. 7.2 (a): IRS-R2, LISS III, 96/48 and 96/49 & (b) Interpreted Layers, 2023

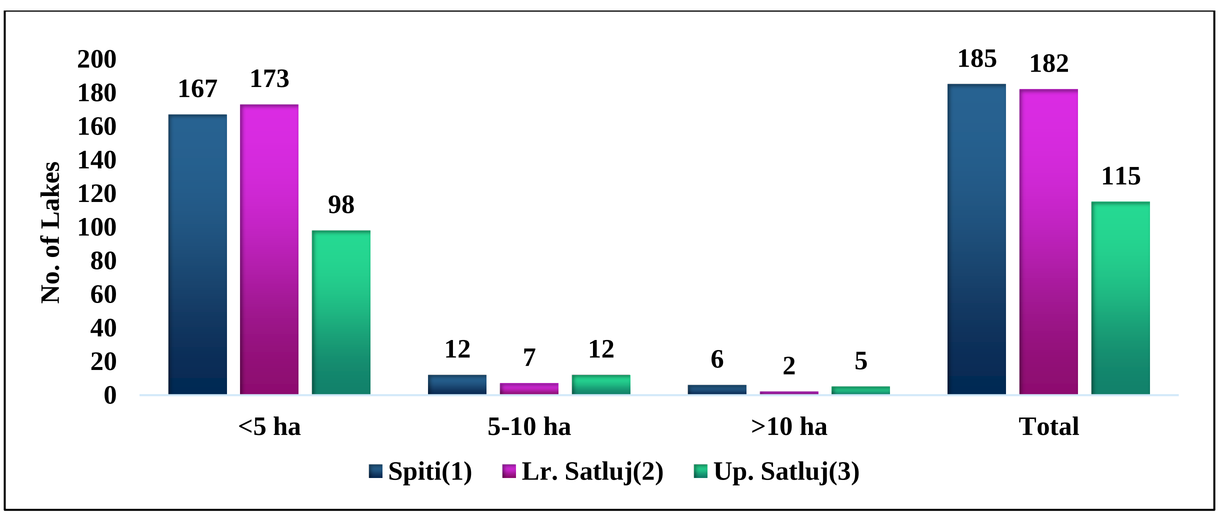


Fig. 7.2 (b): No of lakes based on IRS-R2, LISS III, 96/48 and 96/49

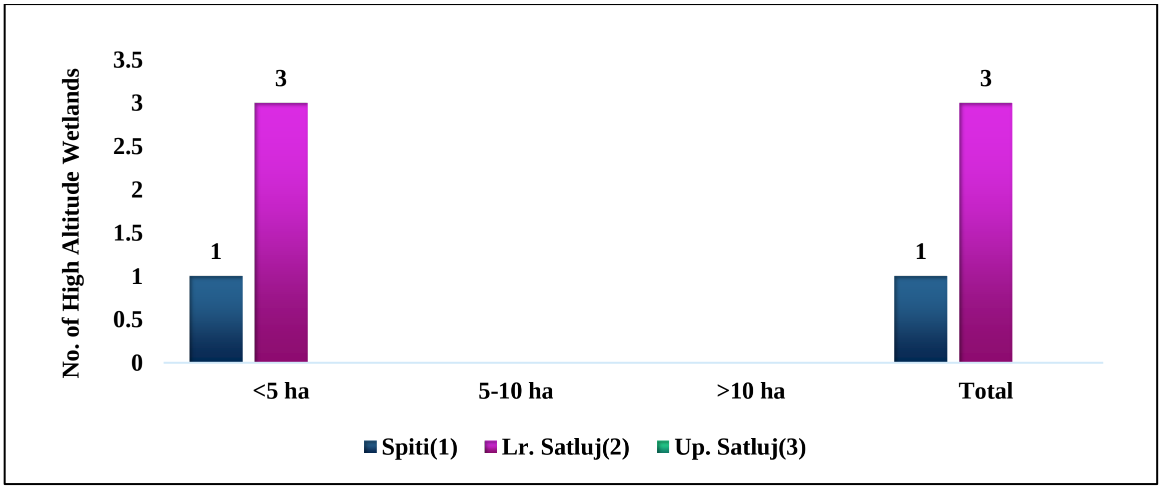


Fig. 7.2 (c): No. of High-Altitude Wetland Lakes based on IRS, R2- LISS III, 96/48 & 96/49

Table 7.1: Distribution of Lakes as per satellite data interpretation for the year 2023 using LISS-III (96-48 & 96-49) sensor

Sr. No.	Lake Id.	Basin No.	Longitude	Latitude	Area extent (in ha) 2023	Area extent (in ha) 2022	Change in Area w.r.t 2022
1.	61	3	32.32	78.99	0.57	0.50	(+)0.07
2.	67	1	32.31	78.37	2.68	1.26	(+)1.43
3.	68	3	32.22	78.98	0.92	0.79	(+)0.12
4.	70	3	32.21	79.02	3.81	3.58	(+)0.23
5.	71	3	32.22	78.99	0.65	0.45	(+)0.19
6.	72	1	32.22	79.00	0.98	1.83	(-)0.85
7.	74	1	32.18	78.43	1.47	1.34	(+)0.13
8.	75	1	32.18	78.98	0.47	0.47	(+)0.00
9.	76	3	32.15	78.96	1.88	2.73	(-)0.85
10.	80	1	32.14	78.96	0.75	0.52	(+)0.23
11.	81	1	32.12	78.94	3.88	6.41	(-)2.53
12.	**84**	**3**	**32.11**	**78.93**	**12.81**	**13.33**	**(-)0.53**
13.	85	3	32.10	78.94	0.52	0.51	(+)0.01
14.	**85**	**2**	**31.66**	**78.17**	**43.72**	**42.80**	**(+)0.92**
15.	94	3	32.02	78.88	2.90	3.10	(-)0.21
16.	95	3	32.01	78.85	0.70	0.68	(+)0.02
17.	96	3	32.03	78.79	0.35	0.19	(+)0.16
18.	97	3	32.02	78.91	7.13	6.55	(+)0.58
19.	99	1	32.03	78.78	0.87	0.95	(-)0.08
20.	101	3	31.99	78.85	2.31	1.72	(+)0.58
21.	103	3	31.96	78.81	0.29	0.29	(+)0.00
22.	105	3	31.98	78.13	2.38	2.37	(+)0.01
23.	106	3	31.98	78.85	0.85	0.66	(+)0.19

24.	**122**	**3**	**31.92**	**78.78**	**21.72**	**21.67**	**(+)0.06**
25.	131	1	31.92	78.70	0.69	0.91	(-)0.22
26.	152	1	32.13	78.93	1.27	1.26	(+)0.01
27.	167	2	31.36	78.70	1.61	0.91	(+)0.70
28.	168	2	31.36	78.72	1.38	1.38	---------
29.	228	2	31.55	78.75	5.47	5.41	(+)0.06
30.	405	2	31.40	78.42	3.27	2.45	(+)0.82
31.	586	1	31.91	78.70	3.23	5.47	(-)2.24
32.	589	1	31.90	78.72	1.36	1.25	(+)0.10
33.	811	1	32.05	78.90	1.27	0.71	(+)0.57
34.	814	1	32.05	78.74	1.27	1.01	(+)0.26
35.	816	1	32.05	78.75	0.36	0.36	-------
36.	819	1	32.04	78.75	1.23	1.05	(+)0.18
37.	820	1	32.04	78.76	0.94	0.74	(+)0.20
38.	821	1	32.04	78.76	2.02	2.47	(-)0.45
39.	822	1	32.04	78.76	1.04	0.83	(+)0.21
40.	825	1	32.04	78.77	0.75	0.46	(+)0.29
41.	848	2	31.71	78.74	2.50	2.49	(+)0.01
42.	854	2	31.56	78.61	3.11	3.83	(-)0.72
43.	865	2	31.36	78.77	0.58	0.52	(+)0.06
44.	866	2	31.36	78.73	2.48	2.50	(-)0.02
45.	869	2	31.33	78.70	2.25	1.94	(+)0.31
46.	870	2	31.33	78.70	2.54	1.79	(+)0.75
47.	871	2	31.33	78.66	1.21	1.22	(-)0.01
48.	891	2	31.46	78.37	1.96	1.69	(+)0.27
49.	998	1	32.71	78.68	1.29	1.01	(+)0.28
50.	999	1	32.61	78.08	0.34	0.45	(-)0.10
51.	1013	3	32.25	78.99	1.96	2.02	(-)0.06
52.	1022	1	32.04	78.78	0.23	0.27	(-)0.04
53.	1033	3	31.91	78.79	0.23	0.21	(+)0.03
54.	1035	1	31.89	78.70	1.62	1.87	(-)0.25
55.	1039	2	31.66	78.75	1.04	0.97	(+)0.07
56.	1048	2	31.37	78.72	0.40	0.40	-------
57.	1049	2	31.52	78.73	4.05	3.12	(+)0.93
58.	1209	2	31.54	78.74	1.78	1.28	(+)0.50
59.	1213	2	31.51	78.73	1.39	1.05	(+)0.34
60.	1218	2	31.49	78.43	1.09	0.33	(+)0.76
61.	1220	2	31.51	78.43	0.23	0.46	(-)0.23
62.	1230	3	32.03	78.78	0.81	0.60	(+)0.21
63.	1231	1	32.04	78.76	0.29	0.38	(-)0.08
64.	1232	1	32.03	78.87	7.25	4.96	(+)2.30
65.	1234	3	31.93	78.69	0.46	0.60	(-)0.15

66.	1237	3	31.93	78.83	0.52	0.58	(-)0.06
67.	1238	3	31.93	78.80	0.32	0.32	------
68.	1259	3	31.97	78.87	9.99	8.94	(+)1.05
69.	1270	2	31.36	78.76	0.92	0.85	(+)0.07
70.	1272	2	31.32	78.76	1.37	1.38	(-)0.01
71.	1273	2	31.32	78.76	1.04	0.95	(+)0.09
72.	1274	2	31.32	78.76	1.19	0.96	(+)0.23
73.	1275	2	31.32	78.76	0.82	0.95	(-)0.13
74.	1619	2	31.45	78.37	1.09	0.60	(+)0.49
75.	1623	2	31.41	78.41	2.15	1.73	(+)0.41
76.	1625	2	31.40	78.43	1.09	0.72	(+)0.37
77.	1626	2	31.40	78.42	1.85	1.75	(+)0.10
78.	1640	2	31.49	78.43	4.88	2.85	(+)2.03
79.	1647	3	31.88	78.79	0.65	0.61	(+)0.03
80.	1648	3	31.88	78.79	1.03	1.10	(-)0.07
81.	1652	3	31.93	78.82	0.29	0.31	(-)0.02
82.	1653	3	31.93	78.82	3.40	2.52	(+)0.88
83.	1654	3	31.91	78.84	7.34	8.45	(-)1.11
84.	1656	1	32.04	78.75	1.18	0.83	(+)0.35
85.	1658	1	32.04	78.78	0.23	0.19	(+)0.04
86.	1660	1	32.03	78.76	1.39	1.21	(+)0.18
87.	1668	1	32.08	78.80	1.13	1.37	(-)0.23
88.	1692	1	32.70	78.74	0.77	0.65	(+)0.11
89.	1693	1	32.70	78.73	0.35	0.40	(-)0.05
90.	1714	2	31.31	78.33	0.41	0.41	------
91.	2100	2	31.53	78.72	1.56	0.76	(+)0.80
92.	2101	2	31.38	78.74	0.41	0.35	(+)0.06
93.	2102	2	31.37	78.74	0.82	0.91	(-)0.09
94.	2104	2	31.36	78.67	0.40	0.30	(+)0.10
95.	2106	2	31.37	78.58	1.26	1.48	(-)0.21
96.	2107	2	31.40	78.49	3.15	4.32	(-)1.17
97.	2113	3	31.93	78.82	1.49	1.49	-------
98.	2114	3	31.94	78.81	0.69	0.30	(+)0.39
99.	2115	3	31.93	78.82	2.63	2.16	(+)0.47
100.	2117	1	32.20	79.02	0.65	0.87	(-)0.22
101.	2117	3	31.93	78.78	0.73	0.37	(+)0.36
102.	2118	1	32.30	78.20	0.51	0.55	(-)0.04
103.	2118	3	31.93	78.78	7.23	7.40	(-)0.18
104.	2120	1	32.09	78.86	1.98	1.89	(+)0.08
105.	5045	1	32.33	78.97	7.47	8.45	(-)0.98
106.	5048	3	32.31	78.18	0.26	0.85	(-)0.59
107.	5056	1	32.21	79.01	1.86	1.80	(+)0.06

108.	5058	3	32.22	79.00	1.93	0.76	(+)1.17
109.	5068	3	32.12	78.95	2.69	5.02	(-)2.33
110.	5073	1	32.14	78.92	4.18	3.01	(+)1.17
111.	5074	1	32.09	78.91	3.44	2.34	(+)1.10
112.	5079	1	32.07	78.88	4.20	4.07	(+)0.14
113.	5081	1	32.06	78.93	2.45	1.78	(+)0.67
114.	**5095**	**3**	**31.99**	**78.84**	**22.27**	**23.26**	**(-)0.98**
115.	6004	1	31.89	78.71	0.50	0.71	(-)0.21
116.	6014	3	31.98	78.84	9.84	6.28	(+)3.56
117.	6016	1	32.71	78.71	4.40	6.56	(-)2.17
118.	6017	1	32.71	78.70	0.57	0.66	(-)0.08
119.	6019	1	32.71	78.71	1.77	1.46	(+)0.31
120.	6035	1	32.04	78.75	0.34	0.30	(+)0.04
121.	**6036**	**1**	**32.03**	**78.84**	**18.92**	**18.72**	**(+)0.20**
122.	9000	1	32.47	78.31	0.55	0.77	(-)0.22
123.	9001	1	32.76	78.70	0.35	0.46	(-)0.12
124.	9001	1	32.76	78.70	0.62	1.06	(-)0.43
125.	9001	1	32.75	78.70	1.42	1.25	(+)0.16
126.	9001	1	32.75	78.70	0.58	0.55	(+)0.03
127.	9002	1	32.48	78.30	2.69	3.03	(-)0.33
128.	9004	1	32.28	79.02	2.96	3.34	(-)0.38
129.	9005	1	32.26	78.98	2.66	2.66	(+)0.01
130.	9006	1	32.22	79.03	8.04	6.47	(+)1.57
131.	9007	1	32.22	79.01	3.00	3.14	(-)0.15
132.	9008	1	32.25	78.99	0.57	0.74	(-)0.16
133.	9009	1	32.35	78.50	0.23	0.20	(+)0.03
134.	9011	1	32.46	78.47	7.37	6.45	(+)0.92
135.	9012	1	32.51	77.81	3.43	2.23	(+)1.21
136.	9014	1	32.42	78.08	4.34	3.98	(+)0.36
137.	**9016**	**1**	**32.36**	**78.27**	**18.16**	**18.38**	**(-)0.23**
138.	9017	1	32.36	78.51	0.59	0.76	(-)0.17
139.	9021	1	32.32	78.99	0.47	0.60	(-)0.13
140.	9027	1	32.17	78.97	2.30	2.01	(+)0.29
141.	9030	1	32.14	78.91	1.74	1.69	(+)0.05
142.	9033	1	31.97	78.87	0.53	0.40	(+)0.13
143.	9036	2	31.86	77.86	0.68	0.77	(-)0.09
144.	9037	1	31.95	78.80	1.25	0.66	(+)0.59
145.	9038	1	32.12	78.95	0.50	0.61	(-)0.11
146.	9040	1	32.23	78.98	2.80	2.59	(+)0.22
147.	9052	2	31.70	77.69	2.08	2.08	(+)0.00
148.	9055	2	31.71	77.88	0.86	0.63	(+)0.24
149.	9056	2	31.72	77.90	2.46	2.46	-------

150.	9057	2	31.72	77.90	2.32	2.31	(+)0.01
151.	9060	2	31.69	78.07	0.75	0.83	(-)0.07
152.	9061	2	31.70	78.08	1.49	1.56	(-)0.07
153.	9062	2	31.74	78.12	3.61	3.18	(+)0.44
154.	9063	2	31.74	78.13	0.46	0.40	(+)0.06
155.	9064	2	31.66	78.16	0.58	0.58	(+)0.00
156.	9065	2	31.58	78.18	1.05	1.08	(-)0.03
157.	9066	2	31.58	78.19	7.98	7.41	(+)0.58
158.	9067	2	31.78	78.29	1.61	2.99	(-)1.38
159.	9068	2	31.79	78.31	2.39	2.50	(-)0.11
160.	9070	2	31.52	78.38	8.06	7.20	(+)0.86
161.	9071	2	31.52	78.39	3.95	3.91	(+)0.04
162.	9074	2	31.49	78.44	0.17	0.42	(-)0.25
163.	9077	2	31.41	78.48	2.40	1.86	(+)0.54
164.	9080	2	31.42	78.41	0.97	0.85	(+)0.12
165.	9081	2	31.44	78.41	2.13	2.01	(+)0.12
166.	9082	2	31.44	78.41	0.22	0.50	(-)0.28
167.	9084	2	31.43	78.08	0.87	0.61	(+)0.26
168.	9085	2	31.42	78.07	1.52	1.33	(+)0.18
169.	9086	2	31.42	78.07	1.68	2.60	(-)0.92
170.	9089	2	31.44	77.92	1.53	1.59	(-)0.06
171.	9091	2	31.57	78.60	0.58	0.57	(+)0.01
172.	9092	2	31.58	78.60	0.75	0.66	(+)0.10
173.	9093	2	31.57	78.60	0.77	0.46	(+)0.31
174.	9095	2	31.47	78.67	0.46	0.69	(-)0.23
175.	9096	2	31.48	78.67	0.34	0.33	(+)0.02
176.	9097	2	31.47	78.68	0.80	0.51	(+)0.29
177.	9098	2	31.49	78.73	0.58	0.37	(+)0.21
178.	9099	2	31.48	78.78	0.34	0.37	(-)0.02
179.	9100	2	31.52	78.69	0.37	0.37	--------
180.	9102	2	31.56	78.75	0.81	0.30	(+)0.50
181.	9103	2	31.56	78.75	0.75	0.41	(+)0.34
182.	9104	2	31.56	78.76	0.40	0.35	(+)0.05
183.	9105	2	31.68	78.74	0.47	0.49	(-)0.02
184.	9106	1	31.89	78.70	0.40	0.42	(-)0.01
185.	9113	1	31.93	78.69	0.47	0.47	--------
186.	9116	1	32.04	78.74	0.64	0.61	(+)0.03
187.	9117	1	32.04	78.76	0.35	0.21	(+)0.14
188.	9118	1	32.04	78.76	0.36	0.35	(+)0.01
189.	9119	1	32.04	78.76	0.83	0.65	(+)0.17
190.	9120	1	32.04	78.76	0.25	0.26	(-)0.01
191.	9122	1	32.04	78.83	0.69	0.73	(-)0.03

192.	9123	1	32.03	78.78	0.58	0.42	(+)0.16
193.	9124	1	32.05	78.78	0.23	1.48	(-)1.25
194.	9125	1	32.04	78.83	0.91	0.78	(+)0.14
195.	9126	3	32.01	78.82	1.98	1.71	(+)0.27
196.	9127	3	32.01	78.85	2.36	2.39	(-)0.03
197.	9128	3	32.01	78.85	0.23	0.40	(-)0.17
198.	9129	3	32.01	78.85	0.23	0.20	(+)0.03
199.	9130	3	32.00	78.71	0.34	0.42	(-)0.07
200.	9131	3	32.07	77.79	0.81	0.40	(+)0.41
201.	9132	1	32.07	78.82	0.57	0.41	(+)0.17
202.	**9135**	**3**	**32.02**	**78.87**	**10.06**	**7.28**	**(+)2.78**
203.	9136	3	31.97	78.80	0.86	0.77	(+)0.09
204.	9137	3	31.98	78.84	0.29	0.32	(-)0.03
205.	9138	3	31.98	78.84	0.48	0.55	(-)0.07
206.	9142	3	31.95	78.81	0.62	0.33	(+)0.28
207.	9143	3	31.93	78.83	0.29	0.25	(+)0.04
208.	9144	3	31.93	78.82	0.23	0.21	(+)0.01
209.	9146	3	31.93	78.82	0.35	0.45	(-)0.11
210.	9148	3	31.91	78.80	1.41	1.33	(+)0.08
211.	9149	3	31.91	78.78	0.35	0.34	(+)0.01
212.	9150	3	31.91	78.79	0.47	0.59	(-)0.13
213.	9151	3	31.91	78.79	0.57	0.35	(+)0.22
214.	9152	3	31.88	78.79	1.28	1.11	(+)0.17
215.	9156	1	32.14	77.91	1.51	2.10	(-)0.59
216.	9157	1	32.18	78.44	0.20	0.20	--------
217.	9158	1	32.21	79.01	0.40	0.62	(-)0.22
218.	9162	1	32.25	79.04	1.52	1.41	(+)0.11
219.	9163	3	32.23	78.25	0.92	0.76	(+)0.15
220.	9164	3	32.24	77.76	2.01	3.48	(-)1.47
221.	9165	3	32.31	78.19	0.69	1.11	(-)0.42
222.	9166	1	32.32	78.99	1.39	1.29	(+)0.10
223.	9167	1	32.57	77.93	1.11	0.99	(+)0.12
224.	9170	1	32.70	78.73	2.70	2.21	(+)0.50
225.	9171	1	32.73	78.69	1.03	1.07	(-)0.04
226.	9172	2	31.35	78.18	0.86	0.62	(+)0.24
227.	**9173**	**2**	**31.34**	**78.25**	**16.26**	**16.35**	**(-)0.09**
228.	9174	2	31.33	78.26	0.69	0.31	(+)0.39
229.	9175	2	31.29	78.30	0.64	0.51	(+)0.13
230.	9176	2	31.31	78.33	0.46	0.46	(+)0.00
231.	9189	2	31.30	78.88	0.20	0.20	-------
232.	9190	2	31.31	78.88	1.78	1.86	(-)0.08
233.	9191	2	31.31	78.88	0.40	0.43	(-)0.03

234.	9193	2	31.29	78.80	0.69	2.41	(-)1.72
235.	9195	2	31.31	78.79	0.23	0.29	(-)0.07
236.	9196	2	31.33	78.75	0.47	0.20	(+)0.27
237.	9204	2	31.33	78.66	1.51	1.41	(+)0.09
238.	9209	2	31.98	78.84	1.22	0.97	(+)0.25
239.	9210	2	31.50	78.43	2.82	2.28	(+)0.54
240.	9212	1	32.14	78.95	0.70	1.17	(-)0.47
241.	9213	3	32.21	78.98	0.47	0.36	0.11
242.	9215	1	32.71	78.71	0.65	0.90	(-)0.26
243.	9217	1	32.33	78.90	2.01	1.62	(+)0.39
244.	9218	1	32.36	78.29	1.47	1.43	0.05
245.	10099	2	31.78	78.10	2.84	3.06	(-)0.22
246.	10100	2	31.78	78.10	1.56	2.93	(-)1.37
247.	10101	2	31.44	77.92	1.45	1.00	(+)0.45
248.	10102	2	31.46	78.37	0.41	0.28	(+)0.12
249.	10103	2	31.45	78.37	0.23	0.34	(-)0.11
250.	10104	2	31.41	78.41	0.23	0.20	(+)0.03
251.	10105	2	31.41	78.41	0.43	0.31	(+)0.12
252.	10110	2	31.43	78.43	0.46	0.27	(+)0.20
253.	10111	2	31.47	78.43	1.84	1.01	(+)0.83
254.	10112	2	31.50	78.43	1.48	0.57	(+)0.90
255.	10113	2	31.49	78.43	0.80	0.91	(-)0.11
256.	10114	2	31.50	78.43	0.75	0.46	(+)0.29
257.	10115	2	31.49	78.43	0.52	0.43	(+)0.09
258.	10116	2	31.49	78.43	2.73	1.93	(+)0.80
259.	10117	2	31.58	78.60	0.38	0.63	(-)0.25
260.	10120	2	31.66	78.75	0.58	0.58	------
261.	10121	2	31.68	78.74	6.35	0.21	(+)6.14
262.	10122	2	31.73	78.74	5.06	5.60	(-)0.54
263.	**10127**	**1**	**32.30**	**78.99**	**13.10**	**14.17**	**(-)1.07**
264.	10128	1	32.28	79.00	0.63	0.57	(+)0.07
265.	10129	1	32.61	77.99	6.18	6.06	(+)0.12
266.	10130	1	32.55	78.43	2.70	2.78	(-)0.08
267.	10131	1	32.34	78.50	0.53	0.60	(-)0.07
268.	10132	1	32.27	78.24	0.34	0.36	(-)0.02
269.	10134	3	32.33	79.00	2.62	2.18	(+)0.43
270.	10135	3	32.26	79.05	0.34	0.24	(+)0.11
271.	10136	1	32.23	78.22	0.82	1.21	(-)0.39
272.	10137	1	32.24	79.03	1.59	1.45	(+)0.13
273.	10138	1	32.21	77.97	9.16	7.67	(+)1.49
274.	10139	3	32.22	78.99	0.58	0.66	(-)0.08
275.	10140	1	32.13	78.97	0.45	0.40	(+)0.05

276.	10141	3	32.10	78.87	0.40	0.51	(-)0.11
277.	10142	1	32.07	78.86	2.89	2.27	(+)0.62
278.	10143	1	32.04	78.76	0.98	0.79	(+)0.19
279.	10144	3	32.01	78.85	1.45	1.23	(+)0.22
280.	10145	3	31.98	78.84	2.80	2.06	(+)0.74
281.	10146	3	31.98	78.84	0.35	0.58	(-)0.23
282.	10147	3	31.99	78.84	0.76	0.35	(+)0.40
283.	10148	3	31.96	78.81	5.17	5.86	(-)0.68
284.	10149	3	31.96	78.42	8.17	8.32	(-)0.15
285.	10150	3	31.96	78.78	1.21	1.04	(+)0.18
286.	10151	3	31.93	78.82	0.23	0.29	(-)0.07
287.	10152	3	31.93	78.82	0.23	0.20	(+)0.03
288.	10153	3	31.93	78.69	0.29	0.20	(+)0.09
289.	10154	3	31.92	78.84	0.17	0.30	(-)0.13
290.	10155	3	31.88	78.79	0.23	0.25	(-)0.01
291.	10156	3	31.88	78.80	0.35	0.20	(+)0.15
292.	10157	3	31.91	78.78	0.35	0.31	(+)0.04
293.	10158	3	31.91	78.78	0.41	0.48	(-)0.07
294.	10159	3	31.93	78.69	0.58	0.50	(+)0.08
295.	10160	3	31.93	78.82	0.18	0.20	(-)0.02
296.	10161	3	31.93	78.78	1.56	1.24	(+)0.32
297.	10162	3	31.93	78.80	0.62	0.61	(+)0.00
298.	10163	3	31.93	78.68	1.10	1.10	(+)0.00
299.	10166	1	32.08	78.81	0.80	0.72	(+)0.08
300.	10168	1	32.07	78.82	1.03	1.02	(+)0.01
301.	10169	1	32.06	78.93	1.90	1.28	(+)0.62
302.	10170	1	32.01	78.93	1.68	1.35	(+)0.33
303.	10173	1	32.04	78.70	2.26	2.03	(+)0.23
304.	10174	1	32.04	78.78	0.22	0.19	(+)0.03
305.	10175	1	32.04	78.76	0.29	0.36	(-)0.07
306.	10176	1	32.03	78.78	0.62	0.62	--------
307.	10177	1	32.04	78.75	0.29	0.22	(+)0.07
308.	10178	1	32.04	78.75	0.46	0.43	(+)0.04
309.	10179	1	31.93	78.81	5.38	3.90	(+)1.48
310.	10180	1	31.93	78.83	0.35	0.42	(-)0.08
311.	10181	1	31.93	78.70	0.63	0.53	(+)0.10
312.	10182	1	31.90	78.72	0.80	0.78	(+)0.02
313.	10183	1	31.90	78.71	1.39	1.17	(+)0.22
314.	10184	1	31.89	78.72	0.40	0.38	(+)0.02
315.	10185	1	32.48	78.32	0.35	0.31	(+)0.04
316.	10186	2	31.70	77.68	0.46	0.46	-------
317.	10187	2	31.52	78.63	0.41	0.35	(+)0.06

318.	10188	2	31.48	78.69	0.52	0.53	(+)0.01
319.	10190	3	32.19	78.97	6.01	5.27	(+)0.73
320.	10191	3	32.19	78.96	3.12	3.15	(-)0.03
321.	**10192**	**1**	**32.21**	**79.04**	**28.29**	**29.26**	**(-)0.97**
322.	**10193**	**1**	**32.16**	**78.98**	**10.25**	**10.22**	**(+)0.04**
323.	10195	1	32.14	78.97	0.23	0.28	(-)0.05
324.	10196	1	32.14	78.96	0.54	1.29	(-)0.76
325.	10197	1	32.14	78.95	0.36	0.59	(-)0.23
326.	10198	1	32.14	78.92	0.29	0.25	(+)0.03
327.	10199	3	32.13	78.97	3.99	4.56	(-)0.58
328.	10200	3	32.12	78.95	1.89	2.11	(-)0.22
329.	10201	3	32.13	77.93	1.11	2.05	(-)0.95
330.	10202	3	32.12	78.95	1.63	1.29	(+)0.34
331.	10203	3	32.12	78.94	0.70	0.76	(-)0.06
332.	**10204**	**3**	**32.11**	**78.94**	**11.27**	**12.49**	**(-)1.22**
333.	10205	3	32.11	78.95	1.10	1.14	(-)0.04
334.	10206	3	32.10	78.92	1.20	1.00	(+)0.20
335.	10207	3	32.10	78.95	0.35	0.30	(+)0.05
336.	10207	3	32.10	78.88	0.59	1.01	(-)0.42
337.	10209	3	32.09	78.95	7.18	6.53	(+)0.65
338.	10210	3	32.09	78.93	1.78	1.44	(+)0.34
339.	10212	3	32.09	78.23	1.80	1.38	(+)0.42
340.	10213	3	32.06	78.80	0.35	0.52	(-)0.17
341.	10214	3	32.06	78.94	8.14	7.77	(+)0.36
342.	10214	3	32.06	78.81	8.86	10.47	(-)1.60
343.	10215	3	32.04	78.90	2.97	2.95	(+)0.02
344.	10216	3	32.04	78.89	2.37	2.79	(-)0.42
345.	10217	1	31.96	78.87	5.09	4.06	(+)1.03
346.	10218	1	31.96	78.70	0.44	0.61	(-)0.18
347.	10219	1	32.40	78.07	1.85	1.73	(+)0.12
348.	10220	1	32.40	78.07	1.74	1.75	(+)0.00
349.	10221	1	32.38	78.46	1.06	1.21	(-)0.15
350.	10222	2	31.56	78.71	1.22	1.27	(-)0.05
351.	10223	2	31.35	78.76	2.22	3.86	(-)1.64
352.	10224	2	31.36	78.73	0.17	0.37	(-)0.20
353.	10225	2	31.30	78.79	2.17	2.17	-------
354.	10227	2	31.41	78.03	7.62	8.77	(-)1.15
355.	10228	2	31.72	77.87	3.16	4.74	(-)1.58
356.	10229	2	31.74	77.86	2.76	3.08	(-)0.31
357.	10230	2	31.76	77.87	0.36	1.00	(-)0.64
358.	10231	2	31.76	77.87	0.51	0.45	(+)0.07
359.	10232	2	31.79	77.91	0.52	1.00	(-)0.48

360.	10233	1	32.43	78.09	2.20	2.41	(-)0.21
361.	10234	1	32.47	78.05	0.70	1.01	(-)0.31
362.	10235	1	32.39	78.06	1.58	1.31	(+)0.27
363.	10236	1	32.35	78.88	1.16	1.30	(-)0.14
364.	10237	1	32.35	78.50	0.70	0.56	(+)0.14
365.	10238	1	32.43	78.09	0.52	0.61	(-)0.09
366.	10239	1	32.43	78.09	1.54	1.19	(+)0.35
367.	10240	1	32.55	77.91	1.26	1.20	(+)0.06
368.	10241	1	32.53	77.97	1.38	1.26	(+)0.12
369.	10242	1	32.49	78.19	1.64	1.82	(-)0.18
370.	10243	1	32.52	77.94	4.04	4.70	(-)0.67
371.	10244	1	32.10	78.91	2.03	1.34	(+)0.69
372.	10245	1	32.09	78.93	0.68	0.66	(+)0.02
373.	10247	2	31.49	78.35	0.51	0.47	(+)0.05
374.	10248	2	31.40	78.75	0.23	1.34	(-)1.11
375.	10291	1	32.89	78.45	9.12	----------	----------
376.	10292	1	32.71	78.69	6.00	----------	----------
377.	10293	1	32.70	78.72	0.67	----------	----------
378.	10294	1	32.69	78.71	3.58	----------	----------
379.	10295	1	32.75	78.72	3.03	----------	----------
380.	10296	2	31.35	78.73	0.47	----------	----------
381.	10297	2	31.33	78.69	0.46	----------	----------
382.	10298	2	31.32	78.36	0.22	----------	----------
383.	10299	2	31.32	78.38	0.74	----------	----------
384.	10300	2	31.30	78.33	1.65	----------	----------
385.	10301	2	31.30	78.31	0.47	----------	----------
386.	10302	2	31.34	78.23	1.25	----------	----------
387.	10303	2	31.41	78.01	5.60	----------	----------
388.	10304	2	31.41	78.03	0.64	----------	----------
389.	10305	2	31.48	77.96	1.82	----------	----------
390.	10306	2	31.64	77.66	0.96	----------	----------
391.	10307	2	31.70	77.71	3.90	----------	----------
392.	10308	2	31.67	77.66	2.97	----------	----------
393.	10309	2	31.67	77.66	2.38	----------	----------
394.	10310	2	31.67	77.66	0.68	----------	----------
395.	10311	2	31.66	77.67	0.27	----------	----------
396.	10312	2	31.68	77.67	1.43	----------	----------
397.	10313	2	31.68	77.67	1.45	----------	----------
398.	10314	2	31.67	77.67	0.51	----------	----------
399.	10315	2	31.68	77.66	0.40	----------	----------
400.	10316	2	31.68	77.67	0.41	----------	----------
401.	10317	2	31.68	77.67	0.64	----------	----------

402.	10318	2	31.75	77.83	0.56	----------	----------
403.	10319	2	31.74	77.87	0.16	----------	----------
404.	10320	2	31.74	77.86	0.24	----------	----------
405.	10321	2	31.73	77.94	1.04	----------	----------
406.	10322	3	31.95	78.78	0.17	----------	----------
407.	10323	3	31.96	78.88	0.48	----------	----------
408.	10324	3	31.97	78.81	2.67	----------	----------
409.	10325	3	32.35	78.97	0.71	----------	----------
410.	10326	1	32.35	78.90	2.47	----------	----------
411.	10327	1	32.39	78.89	1.62	----------	----------
412.	10328	1	32.40	78.89	0.62	----------	----------
413.	10329	1	32.41	78.83	0.26	----------	----------
414.	10330	1	32.75	78.52	8.55	----------	----------
415.	10331	1	32.60	77.68	3.29	----------	----------
416.	10332	1	32.60	77.68	0.24	----------	----------
417.	10333	1	32.44	77.69	0.58	----------	----------
418.	10334	2	31.22	78.79	0.17	----------	----------
419.	10107 SG	2	31.45	78.45	0.81	0.53	(+)0.28
420.	10108 SG	2	31.46	78.45	0.63	0.46	(+)0.17
421.	10109 SG	2	31.46	78.45	0.82	0.43	(+)0.40
422.	10123 SG	1	32.34	78.50	0.52	0.51	(+)0.01
423.	**10124**	**1**	**32.33**	**78.72**	**114.01**	**118.91**	**(-)4.90**
424.	10125 SG	1	32.33	78.91	3.43	2.94	(+)0.48
425.	10126 SG	1	32.33	78.91	2.89	2.12	(+)0.77
426.	1216SG	2	31.37	78.58	0.85	0.71	(+)0.15
427.	1265SG	2	31.25	78.62	0.69	0.54	(+)0.16
428.	1310SG	2	31.25	78.56	0.64	0.71	(-)0.07
429.	1649SG	1	31.90	78.70	0.47	0.26	(+)0.21
430.	1682RS	1	32.42	78.83	1.46	2.05	(-)0.60
431.	1683RS	1	32.42	78.82	8.97	11.82	(-)2.85
432.	1684RS	1	32.42	78.22	2.44	3.81	(-)1.37
433.	1685RS	1	32.41	78.83	0.74	2.37	(-)1.63
434.	1686RS	1	32.38	78.46	0.63	0.43	(+)0.20

435.	1687RS	1	32.38	78.48	1.32	1.19	(+)0.13
436.	171HWL	2	31.37	78.80	2.14	1.41	(+)0.73
437.	49HWL	1	32.32	78.53	2.53	1.61	(+)0.92
438.	582(1)	2	31.32	78.33	0.76	0.70	(+)0.06
439.	582(4)	2	31.31	78.33	0.58	0.46	(+)0.12
440.	582(4)	2	31.31	78.33	2.75	2.39	(+)0.35
441.	582(5)	2	31.31	78.33	0.57	0.44	(+)0.13
442.	582(5)	2	31.31	78.33	0.66	0.60	(+)0.06
443.	582(5)	2	31.31	78.33	0.23	0.20	(+)0.03
444.	9003RS	1	32.38	78.26	1.61	1.59	(+)0.02
445.	9018SG	1	32.34	79.00	4.79	3.13	(+)1.65
446.	9019SG	1	32.34	78.50	0.23	0.21	(+)0.03
447.	9020SG	1	32.34	78.50	2.14	2.87	(-)0.73
448.	9058RS	2	31.72	77.90	0.46	0.41	(+)0.05
449.	9068HWL	2	31.73	78.40	2.82	2.91	(-)0.09
450.	9069HWL	2	31.73	78.40	1.27	1.02	(+)0.25
451.	9072SG	2	31.48	78.41	0.52	0.62	(-)0.10
452.	9075SG	2	31.44	78.45	0.23	0.58	(-)0.34
453.	9075SG	2	31.44	78.45	0.52	0.40	(+)0.12
454.	9078SG	2	31.39	78.43	0.52	0.75	(-)0.23
455.	9083SG	2	31.46	78.39	0.93	0.53	(+)0.40
456.	9107SG	1	31.91	78.71	0.92	0.73	(+)0.19
457.	9108SG	1	31.93	78.70	1.09	0.61	(+)0.48
458.	9109SG	1	31.93	78.82	0.34	0.35	(-)0.01
459.	9110SG	1	31.93	78.82	1.79	1.79	(+)0.00
460.	9110SG	1	31.93	78.69	0.34	0.21	(+)0.12
461.	9111SG	1	31.93	78.82	0.91	0.89	(+)0.02
462.	9112SG	1	31.93	78.69	0.99	0.76	(+)0.23

463.	9114SG	1	32.00	78.90	2.37	2.15	(+)0.22
464.	9139SG	3	31.96	78.80	0.79	0.28	(+)0.51
465.	9140SG	3	31.95	77.78	1.49	1.32	(+)0.17
466.	9141SG	3	31.95	78.81	1.59	1.08	(+)0.51
467.	9153SG	3	31.88	78.80	0.57	0.72	(-)0.14
468.	9154SG	3	31.87	78.80	0.86	0.56	(+)0.30
469.	9177SG	2	31.30	78.37	0.41	0.40	(+)0.00
470.	9179SG	2	31.26	78.48	0.22	0.40	(-)0.18
471.	9180SG	2	31.26	78.48	1.03	0.50	(+)0.53
472.	9184SG	2	31.21	78.71	0.46	0.20	(+)0.26
473.	9185SG	2	31.21	78.72	0.67	0.36	(+)0.31
474.	9186SG	2	31.20	78.72	0.88	0.83	(+)0.04
475.	9198SG	2	31.35	78.68	0.41	0.56	(-)0.15
476.	9199SG	2	31.35	78.68	0.06	0.14	(-)0.09
477.	9200SG	2	31.35	78.68	0.23	0.36	(-)0.12
478.	9201SG	2	31.36	78.68	0.23	0.20	(+)0.03
479.	9202SG	2	31.36	78.68	0.20	0.30	(-)0.10
480.	9207RS	2	31.62	78.02	4.74	4.55	(+)0.19

HWL= High Altitude Wetland
RS= River Section
SG= Supra Glacier lakes

Based on the analysis of 97/48 and 97/49 LISS III satellite data product for 2023, a total of 160 lakes were delineated from the interpretation of satellite data (Fig.7.3 (b)) in comparison to 155 lakes as mapped in 2022, 119 lakes in 2021, 208 lakes in 2020, 86 lakes in 2019 and 72 lakes in 2018 all forming part of the Upper Satluj basin i.e., the basin 3. Further analysis of 160 lakes reveals that138 lakes are with an area less than 5 ha, 19 lakes are having area between 5 to 10 ha and 3 lakes are the big one with area more than 10 ha and all forming part of the Upper Satluj sub basin (Fig. 7.3 (c)). Further out of 160 lakes, 5 have been identified as high-altitude wetlands forming part of the Upper Satluj basin, with 1 wetland each with area less than 5ha and 5-10ha and 3 having area more than 10 ha (Fig. 7.3(d)). Temporal analysis of Table 7.2 reflects that 101 have shown a positive trend in 2023 i.e., the water spread area has increased in 2023 in comparison to 2022 and 37 number of lakes have shown reduction in their water spread in 2023. The lakes which could not be seen temporally, forms the base line data for its temporal analysis in next ablation season.

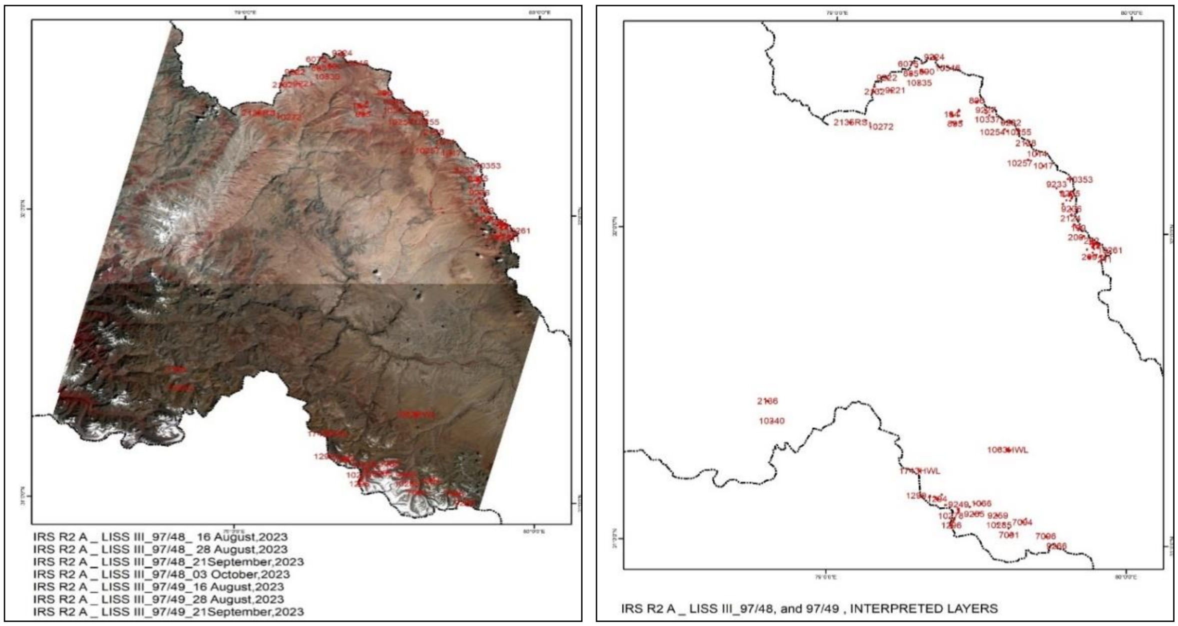


Fig. 7.3 (a): IRS R-2, LISS III, 97/48and 97/49, 2023 & (b) Interpreted Layers, 2023

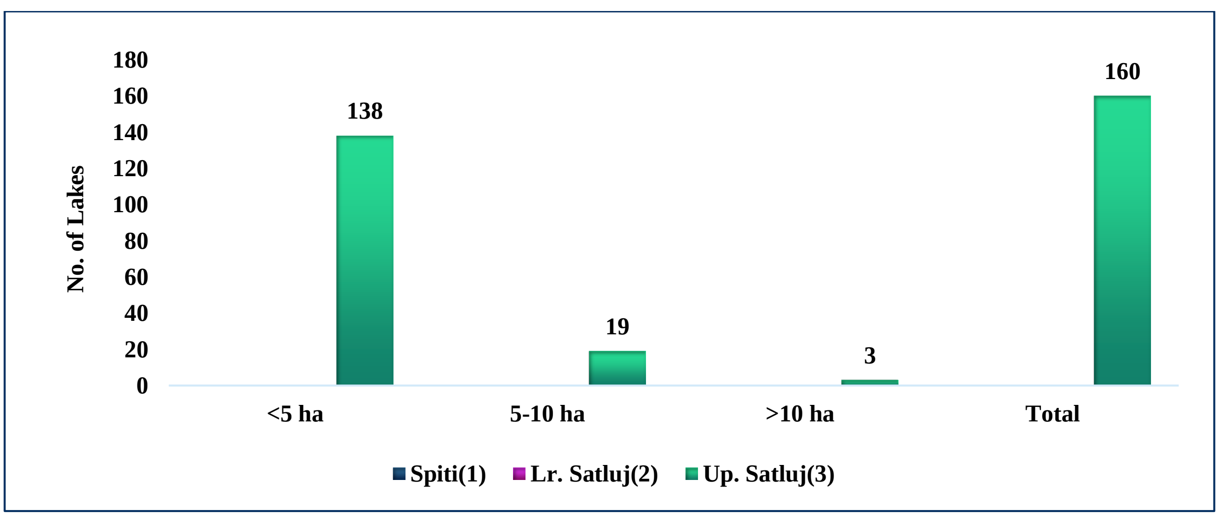


Fig. 7.3(b): No. of lakes-based IRS R-2, LISS III, 97/48 and 97/49

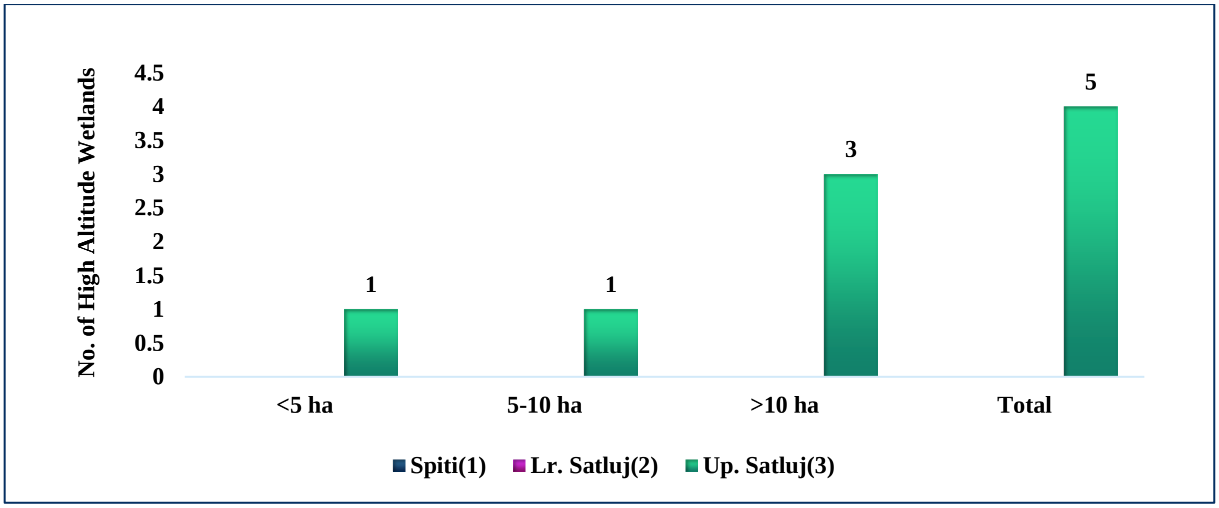


Fig. 7.3(c): No. of high-altitude wetland Lakes based IRS R-2, LISS III, 97/48and 97/49

Table 7.2: Distribution of Lakes as per satellite data interpretation for the year 2023 using LISS-III (97/48 &97/49) sensor

Sr. No.	Lake Id.	Basin No.	Longitude	Latitude	Area extent (in ha) 2023	Area extent (in ha) 2022	Change in Area w.r.t 2022
1	199	3	32.02	79.83	3.67	3.66	(+)0.02
2	200	3	31.99	79.84	2.99	2.84	(+)0.15
3	202	3	31.98	79.87	9.69	10.60	(-)0.91
4	203	3	31.97	79.88	4.49	5.11	(-)0.62
5	204	3	31.97	79.88	5.26	5.16	(+)0.09
6	207	3	31.96	79.88	5.52	6.02	(-)0.50
7	208	3	31.95	79.86	2.70	2.94	(-)0.24
8	**209**	**3**	**31.92**	**79.86**	**36.76**	**34.77**	**(+)1.99**
9	210	3	31.93	79.88	3.55	3.30	(+)0.26
10	211	3	31.93	79.90	2.35	2.34	(+)0.01
11	665	3	31.97	79.89	4.22	4.71	(-)0.48
12	806	3	32.42	79.48	1.62	1.44	(+)0.18
13	885	3	32.51	79.25	7.39	6.58	(+)0.82
14	887	3	32.52	79.29	1.33	1.35	(-)0.03
15	890	3	32.51	79.29	3.75	3.17	(+)0.58
16	891	3	32.51	79.30	1.44	1.59	(-)0.15
17	895	3	32.35	79.41	5.22	5.12	(+)0.10
18	1008	3	32.42	79.47	0.76	0.76	-------
19	1014	3	32.25	79.68	7.92	8.25	(-)0.33
20	1017	3	32.22	79.71	4.12	3.79	(+)0.33
21	1023	3	32.03	79.81	2.21	2.20	(+)0.01
22	1029	3	31.93	79.92	2.01	1.73	(+)0.28

23	1066	3	31.13	79.51	6.49	7.48	(-)0.99
24	1290	3	31.15	79.32	2.16	2.15	(+)0.01
25	1291	3	31.15	79.34	6.59	6.56	(+)0.02
26	1292	3	31.15	79.36	2.74	2.73	(+)0.01
27	1293	3	31.15	79.36	0.89	0.89	------
28	1294	3	31.14	79.37	8.00	7.97	(+)0.03
29	1295	3	31.06	79.41	4.75	4.73	(+)0.02
30	1296	3	31.06	79.42	0.75	0.74	(+)0.01
31	1296	3	31.06	79.41	5.51	5.49	(+)0.02
32	1728	3	32.38	79.51	2.25	4.37	(-)2.13
33	1729	3	32.39	79.53	0.97	1.18	(-)0.21
34	1732	3	32.13	79.80	2.74	2.69	(+)0.05
35	1733	3	32.12	79.80	3.16	2.35	(+)0.81
36	1734	3	32.11	79.80	1.04	1.01	(+)0.03
37	1738	3	31.96	79.88	3.54	2.94	(+)0.61
38	1739	3	31.96	79.87	1.12	1.10	(+)0.02
39	2121	3	31.92	79.91	0.78	1.33	(-)0.55
40	2122	3	31.97	79.87	0.52	0.65	(-)0.13
41	2123	3	32.03	79.81	0.57	0.57	------
42	2124	3	32.06	79.80	1.20	1.19	(+)0.01
43	2126	3	32.09	79.77	3.50	2.63	(+)0.87
44	2127	3	32.12	79.77	0.35	0.34	(+)0.00
45	2128	3	32.29	79.65	2.67	3.32	(-)0.65
46	2132	3	32.45	79.13	6.75	6.43	(+)0.31
47	2134	3	32.35	79.10	3.99	4.18	(-)0.19
48	2136	3	31.45	78.79	9.45	9.91	(-)0.47
49	6075	3	32.53	79.27	2.79	2.80	(-)0.02
50	6076	3	32.38	79.52	1.06	0.97	(+)0.08
51	6080	3	32.11	79.78	0.71	0.35	(+)0.36
52	6083	3	32.03	79.81	0.58	0.57	------
53	6086	3	31.96	79.87	0.47	0.68	(-)0.21
54	6089	3	31.93	79.91	0.94	0.94	------
55	6090	3	31.94	79.88	0.85	0.84	(+)0.01
56	6092	3	31.13	79.49	2.10	2.09	(+)0.01
57	7091	3	31.03	79.61	1.75	2.19	(-)0.45
58	7092	3	31.04	79.62	0.48	0.47	(+)0.01
59	7094	3	31.07	79.65	1.77	1.95	(-)0.18
60	7096	3	31.03	79.73	8.40	11.74	(-)3.34
61	9220	3	32.46	79.13	3.85	2.97	(+)0.87
62	9221	3	32.45	79.19	3.48	3.16	(+)0.32
63	9222	3	32.49	79.17	6.23	4.85	(+)1.38
64	9223	3	32.55	79.33	2.24	2.75	(-)0.51

65	9224	3	32.56	79.33	4.43	4.14	(+)0.29
66	**9225**	**3**	**32.39**	**79.42**	**11.76**	**10.96**	**(+)0.80**
67	9226	3	32.37	79.42	3.12	3.11	(+)0.01
68	9227	3	32.39	79.51	2.83	3.59	(-)0.76
69	9229	3	32.35	79.56	1.29	1.17	(+)0.13
70	9230	3	32.33	79.58	1.67	1.46	(+)0.20
71	9231	3	32.35	79.59	4.76	4.58	(+)0.18
72	9232	3	32.35	79.59	7.29	7.26	(+)0.03
73	9233	3	32.14	79.75	1.69	2.71	(-)1.01
74	9234	3	32.13	79.76	0.40	0.40	-----
75	9235	3	32.13	79.80	4.49	3.26	(+)1.23
76	9236	3	32.08	79.80	4.57	4.09	(+)0.48
77	9237	3	32.06	79.80	0.46	0.46	------
78	9238	3	32.02	79.83	0.29	0.29	-------
79	9239	3	32.01	79.83	0.58	0.58	------
80	9240	3	31.97	79.88	0.92	0.92	-------
81	9241	3	31.95	79.88	1.24	1.23	(+)0.01
82	9242	3	31.93	79.89	0.51	0.51	-------
83	9243	3	31.93	79.91	0.52	0.51	(+)0.02
84	9244	3	31.94	79.93	1.04	1.15	(-)0.11
85	9245	3	31.15	79.37	0.44	0.44	-------
86	9246	3	31.16	79.38	2.79	2.78	(+)0.01
87	9247	3	31.13	79.39	1.37	1.37	(+)0.01
88	9248	3	31.13	79.40	0.79	0.79	(+)0.00
89	9249	3	31.11	79.44	1.04	1.04	--------
90	9250	3	31.11	79.44	2.13	2.13	(+)0.01
91	9251	3	31.11	79.44	0.47	0.47	-------
92	9252	3	31.11	79.44	0.70	0.70	-------
93	9253	3	31.10	79.44	0.30	0.30	-------
94	9255	3	31.10	79.49	3.79	5.86	(-)2.07
95	9256	3	31.10	79.51	2.90	2.89	(+)0.01
96	9259	3	31.09	79.57	2.40	3.71	(-)1.31
97	9261	3	31.10	79.56	0.54	0.53	-------
98	9262	3	31.07	79.57	0.36	0.36	-------
99	9265	3	31.08	79.66	0.81	0.81	-------
100	9266	3	31.00	79.77	1.52	1.44	(+)0.09
101	10249	3	32.35	79.05	0.22	0.42	(-)0.20
102	10250	3	32.44	79.12	0.41	0.41	-------
103	10251	3	32.52	79.29	1.06	1.35	(-)0.29
104	10254	3	32.33	79.57	2.27	2.87	(-)0.61
105	10255	3	32.33	79.62	3.14	3.26	(-)0.12
106	10257	3	32.23	79.65	3.76	3.39	(+)0.36

107	10258	3	31.99	79.85	5.07	5.12	(-)0.05
108	10259	3	31.96	79.90	6.15	6.42	(-)0.27
109	10260	3	31.96	79.89	1.02	1.16	(-)0.14
110	10261	3	31.96	79.89	4.25	4.17	(+)0.08
111	10262	3	31.96	79.89	0.68	1.09	(-)0.40
112	10263	3	31.93	79.90	0.21	0.21	--------
113	10265	3	31.92	79.91	0.89	0.78	(+)0.11
114	10266	3	31.92	79.91	0.63	0.62	(+)0.01
115	10267	3	31.92	79.90	0.60	0.60	--------
116	10269	3	32.35	79.39	0.86	0.84	(+)0.02
117	10270	3	32.36	79.43	3.55	1.90	(+)1.66
118	10272	3	32.33	79.12	0.76	1.13	(-)0.37
119	10273	3	32.35	79.12	0.45	0.49	(-)0.04
120	10275	3	31.06	79.42	0.52	0.52	--------
121	10276	3	31.07	79.42	0.74	0.74	--------
122	10277	3	31.08	79.42	0.39	0.39	--------
123	10278	3	31.08	79.42	2.81	2.80	(+)0.01
124	10279	3	31.09	79.42	1.02	1.02	-------
125	10280	3	31.11	79.44	0.65	0.65	-------
126	10281	3	31.10	79.44	0.57	0.57	-------
127	10282	3	31.10	79.44	0.77	0.77	-------
128	10283	3	31.12	79.47	2.44	2.43	(+)0.01
129	10285	3	31.07	79.59	0.55	0.55	-------
130	10335	3	32.48	79.28	1.34	----------	----------
131	10336	3	32.42	79.48	1.66	----------	----------
132	10337	3	32.37	79.53	2.84	----------	----------
133	10338	3	32.33	79.62	2.24	----------	----------
134	10339	3	31.46	78.78	1.43	----------	----------
135	10340	3	31.39	78.81	1.29	----------	----------
136	10341	3	32.45	79.15	1.49	----------	----------
137	10342	3	32.46	79.15	0.12	----------	----------
138	10343	3	32.55	79.32	0.51	----------	----------
139	10344	3	32.54	79.29	0.81	----------	----------
140	10345	3	32.54	79.26	0.18	----------	----------
141	10346	3	32.52	79.37	1.29	----------	----------
142	10347	3	32.35	79.40	0.93	----------	----------
143	10348	3	32.13	79.77	2.71	----------	----------
144	10349	3	32.12	79.78	1.00	----------	----------
145	10350	3	32.13	79.80	1.24	----------	----------
146	10351	3	32.12	79.79	3.90	----------	----------
147	10352	3	32.11	79.80	1.27	----------	----------
148	10353	3	32.17	79.80	1.23	----------	----------

149	10354	3	32.18	79.79	1.29	----------	----------
150	10355	3	31.07	79.65	0.57	----------	----------
151	10356	3	31.08	79.65	0.79	----------	----------
152	10267SG	3	32.35	79.39	0.83	0.84	(-)0.02
153	10274HWL	3	31.31	79.58	0.64	0.64	---------
154	10287SG	3	31.05	79.61	0.45	0.45	---------
155	10290HWL	3	31.30	79.61	2.29	2.28	(+)0.01
156	**1063HWL**	**3**	**31.30**	**79.60**	**56.41**	**56.17**	**(+)0.23**
157	1743HWL	3	31.23	79.31	5.97	5.94	(+)0.02
158	2135RS	3	32.35	79.05	6.65	6.44	(+)0.20
159	6091HWL	3	31.24	79.30	0.76	0.76	--------
160	9254SG	3	31.08	79.42	0.56	0.56	--------

HWL= High Altitude Wetland
RS= River Section
SG= Supra Glacier lakes

A total of 58 lakes could be identified based on the interpretation of satellite data for path rows 98/49 (Fig. 7.4 (b)). Further analysis of 58 lakes reveals that 53 lakes have an area less than 5 ha, 2 lakes have an aerial range of 5 to 10 ha and 3 lakes have an area larger than 10 ha; all of these falls are in the Upper Satluj sub basin (Fig. 7.3 (c)). The lakes mapped in 2023 could be seen temporally with that of 2022 as there was gap in the data during 2022 due to non-availability of cloud free satellite images.

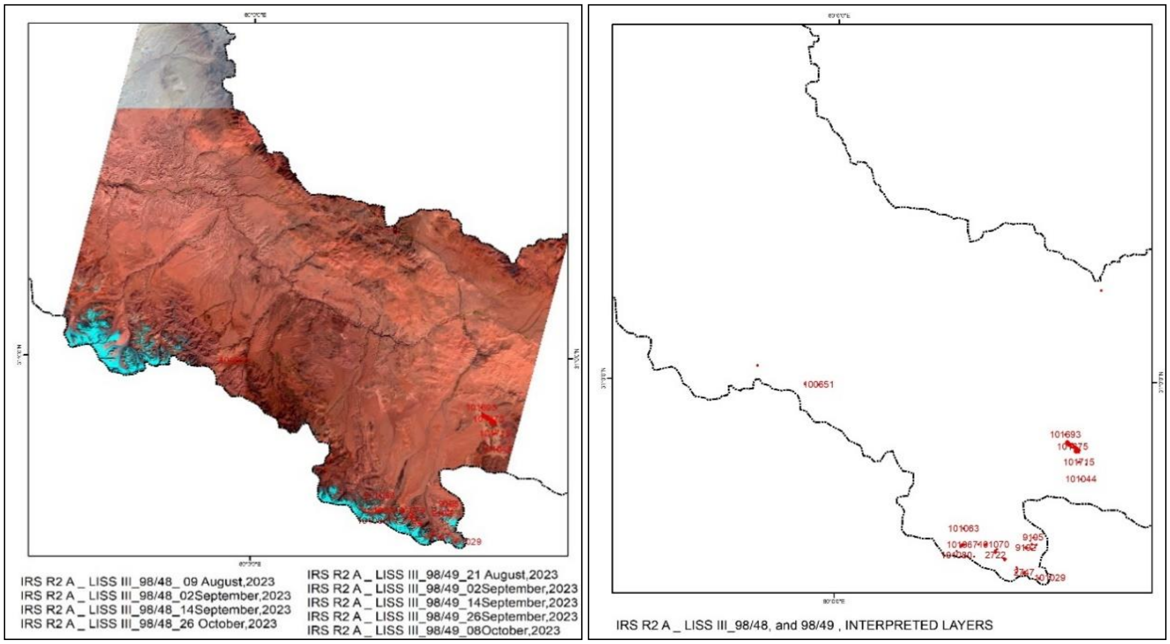


Fig. 7.4 (a): IRS R-2, LISS III, 98/49 and Fig.7.4 (b): IRS R-2, LISS III, 98/49, Interpreted Layers

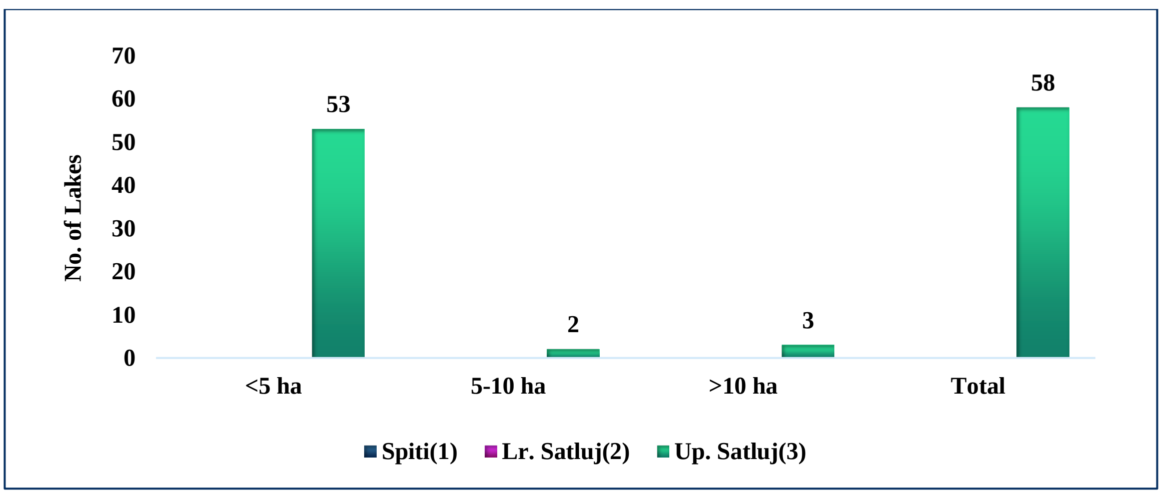


Fig. 7.4 (c): No. of lakes based on IRS R-2, LISS III, 98/49

Table 7.3: Distribution of Lakes as per satellite data interpretation for the year 2023 using LISS-III (98/49) sensor

Sr. No.	Lake Id.	Basin No.	Longitude	Latitude	Area extent (in ha) 2023
1	10387	3	30.5645	80.6115	0.07
2	10388	3	30.5553	80.6168	1.31
3	10389	3	30.5541	80.6168	0.94
4	10390	3	30.5537	80.631	1.33
5	10391	3	30.5474	80.5989	0.12
6	10392	3	30.545	80.6266	0.15
7	10393	3	30.5411	80.5081	0.81
8	10394	3	30.5415	80.615	0.29
9	10395	3	30.5381	80.5048	0.21
10	10396	3	30.5371	80.5011	0.23
11	10397	3	30.5352	80.5041	0.31
12	10398	3	30.532	80.5032	2.71
13	10399	3	30.5151	80.5286	0.36
14	10400	3	30.5141	80.534	1.45
15	10401	3	30.5141	80.5356	0.09
16	10402	3	30.514	80.5349	0.04
17	10403	3	30.511	80.532	2.12
18	10404	3	30.4923	80.5686	0.09
19	10405	3	30.4912	80.5695	0.42
20	10406	3	30.4876	80.5714	0.13
21	10407	3	30.4771	80.5688	3.50
22	10408	3	30.5448	80.5978	7.81
23	10409	3	30.5425	80.6158	0.42
24	10410	3	30.5125	80.5325	0.98
25	10411	3	30.4923	80.5686	0.09
26	10412	3	30.4912	80.5695	0.42
27	10413	3	30.4876	80.5714	0.13
28	**10414**	**3**	**30.4765**	**80.5923**	**14.27**
29	10415	3	30.4626	80.6399	0.73
30	10416	3	30.4599	80.6401	0.35
31	10417	3	30.5725	80.6203	0.21
32	10418	3	30.7338	80.77	2.87
33	10419	3	30.696	80.9978	4.50

34	10420	3	30.712	81.0066	1.05
35	10421	3	30.5971	80.4033	4.20
36	10422	3	30.5537	80.4499	1.91
37	10423	3	30.5468	80.3945	3.37
38	10424	3	30.5492	80.3946	0.99
39	**10425**	**3**	**30.552**	**80.3996**	**27.18**
40	10426	3	30.5533	80.4061	2.00
41	10427	3	30.5529	80.4719	9.05
42	10428	3	30.5556	80.4754	0.44
43	10429	3	30.5348	80.3821	0.81
44	10430	3	30.5201	80.436	0.43
45	**10431RS**	**3**	**30.8231**	**80.7434**	**287.88**
46	10432	3	30.8561	80.7209	2.28
47	10433	3	30.8071	80.7631	0.73
48	10434	3	30.7796	80.7613	0.47
49	10435	3	30.7803	80.7634	1.16
50	10436	3	30.7818	80.7643	0.24
51	10437	3	30.7818	80.7654	0.03
52	10438	3	30.7747	80.7868	1.13
53	10439	3	30.7738	80.7854	0.55
54	10440	3	30.99	79.9024	0.69
55	10441	3	30.9906	79.9031	0.53
56	10442	3	30.9892	79.9461	0.78
57	10443	3	31.2518	80.8324	4.46
58	10444	3	31.0402	79.7534	2.99

HWL= High Altitude Wetland
RS= River Section
SG= Supra Glacier lakes

The area forming part of the path row 99/49 and 100/49 comprises of Upper Satluj sub basin only and based on interpretation using satellite data for 99/49 and 100/49 (Fig. 7.4 (b)), a total of 348 lakes were mapped in 2023 in comparison to 362 (2022), 311 (2021), 348 (2020) and 275 (2019) from the Upper Satluj basin. Further, out of these 348 lakes 271 lakes have been classified as the small one with area less than 5ha against 281 (2022) reflecting reduction of about 4 % in case of small lakes in the Upper Satluj basin .Likewise 37 lakes have been classified with area ranging between 5-10 ha against 39 lakes

(2022) indicating decrease of 5% in 2022 and 40lakes have been classified as the big one with area more than 10ha against the 42 lakes (2022) indicating decrease of about 5% in the category of bigger lakes (Fig: 7.4 (c)). Further 57 lakes have been classified as high-altitude wetlands as in 2023 out of 348 mapped from 99/49 and 100/49 path rows LISS III images comprising 40 wetlands with area less than 5ha, 5 within the areal range of 5-10 ha and 12 the big one with area more than 10ha (Fig: 7.4 (d)) against 43(2022), 42 (2021), 51 (2020) and 45 (2019) respectively.

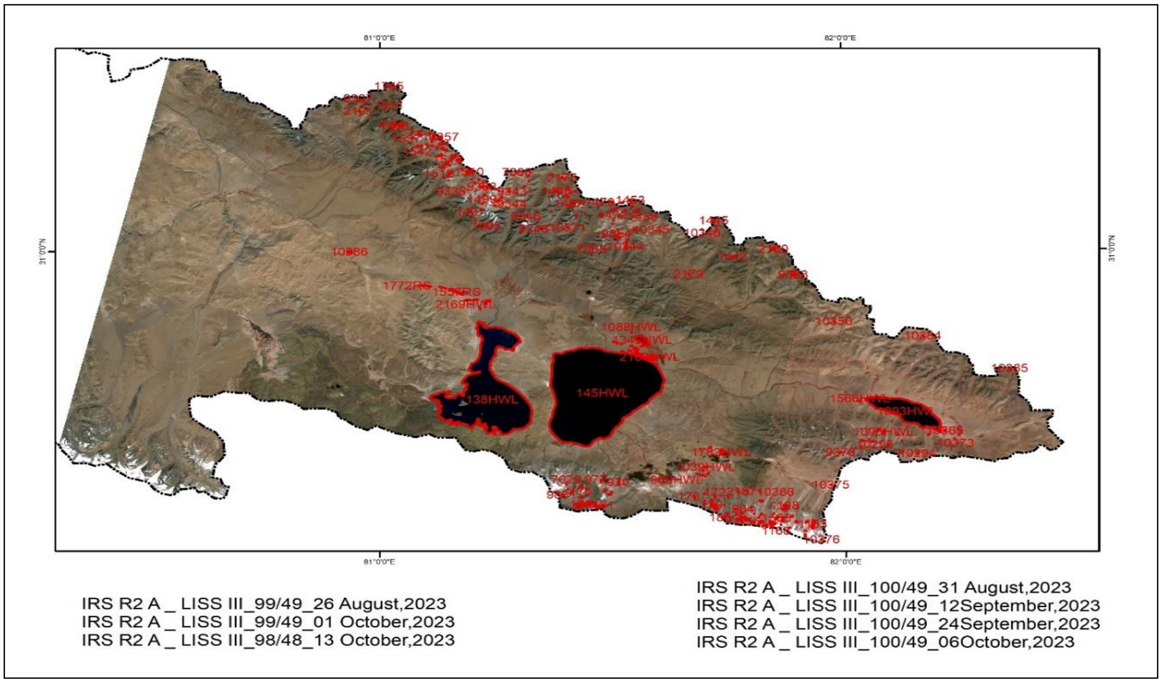


Fig. 7.4 (d): IRS-R2, LISS III, 99/49 & 100/49

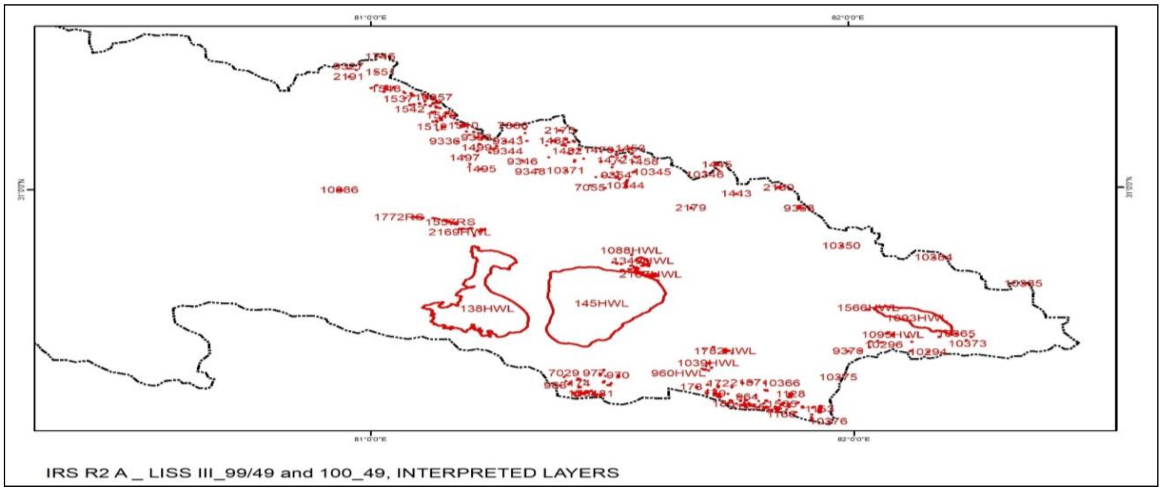


Fig. 7.4 (e): IRS-R2, LISS III, 99/49 & 100/49, interpreted layer

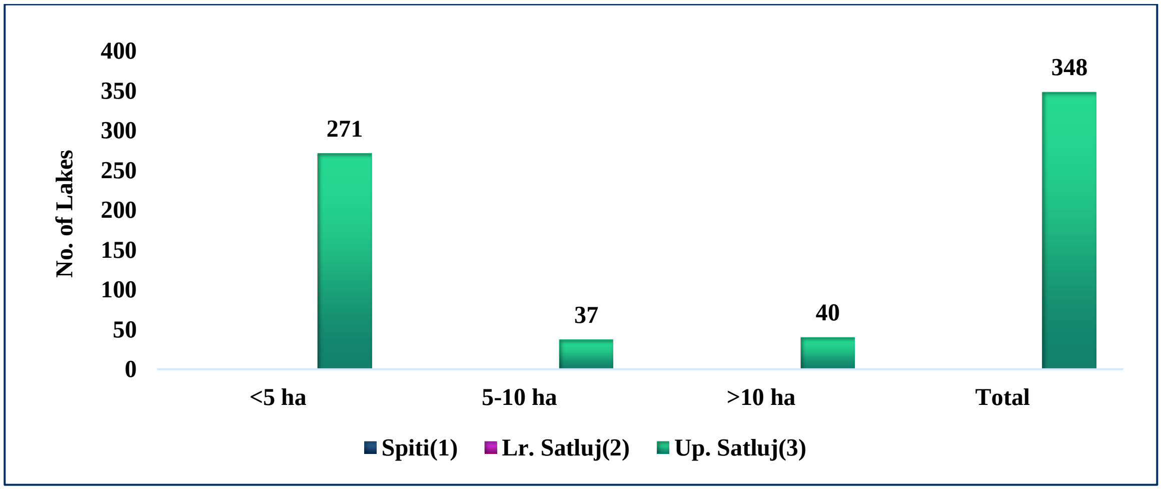


Fig. 7.4 (f): No. of lakes based on IRS-R2, LISS III, 99/49 & 100/49

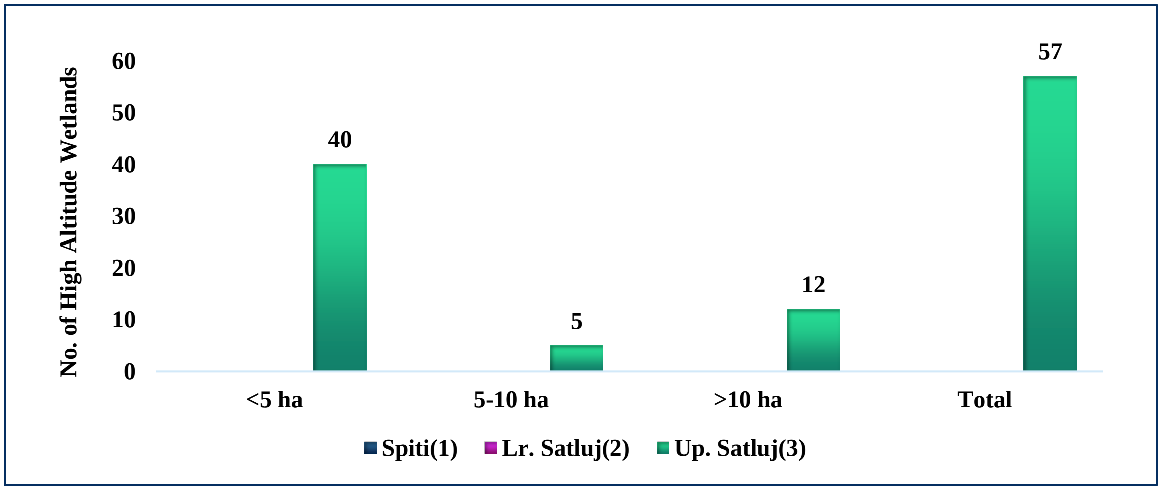


Fig. 7.4 (g): No. of High-Altitude Wetland lakes based on IRS-R2, LISS III 99/49 & 100/49

Table 7.4: Distribution of Lakes as per satellite data interpretation for the year 2023 using LISS-III (99-49 & 100-49) sensor

Sr. No.	Lake Id.	Basin No.	Longitude	Latitude	Area extent (in ha) 2023	Area extent (in ha) 2022	Change in Area w.r.t 2022
1	98	3	81.40	81.40	0.55	0.54	(+)0.01
2	166	3	81.43	81.43	7.80	6.96	(+)0.84
3	172	3	81.72	81.72	8.61	7.87	(+)0.74
4	173	3	81.68	81.68	9.30	9.51	(-)0.21
5	174	3	81.43	81.43	8.77	9.64	(-)0.87
6	**178**	**3**	**81.43**	**81.43**	**205.68**	**204.39**	**(+)1.29**
7	**179**	**3**	**81.71**	**81.71**	**26.79**	**25.88**	**(+)0.91**
8	**181**	**3**	**81.46**	**81.46**	**18.09**	**18.31**	**(-)0.22**
9	**184**	**3**	**81.72**	**81.72**	**23.04**	**23.51**	**(-)0.47**
10	**185**	**3**	**81.75**	**81.75**	**10.95**	**10.71**	**(+)0.24**
11	282	3	81.72	81.72	4.24	3.66	(+)0.58
12	964	3	81.77	81.77	1.86	1.88	(-)0.02
13	966	3	81.74	81.74	5.35	5.78	(-)0.43
14	968	3	81.70	81.70	2.61	3.26	(-)0.65
15	969	3	81.70	81.70	5.98	5.68	(+)0.30
16	970	3	81.51	81.51	8.40	9.15	(-)0.75
17	971	3	81.51	81.51	4.46	3.92	(+)0.54
18	972	3	81.49	81.49	2.30	2.5	(-)0.20
19	973	3	81.50	81.50	0.23	0.2	(+)0.03
20	975	3	81.48	81.48	1.70	0.35	(+)1.35
21	976	3	81.48	81.48	1.00	0.58	(+)0.42
22	977	3	81.47	81.47	2.07	1.58	(+)0.49
23	978	3	81.46	81.46	3.84	4.29	(-)0.45
24	983	3	81.39	81.39	2.59	2.41	(+)0.18
25	989	3	81.48	81.48	2.13	1.91	(+)0.22
26	990	3	81.48	81.48	3.78	3.98	(-)0.20
27	996	3	81.50	81.50	2.70	2.5	(+)0.20
28	1102	3	81.49	81.49	0.63	0.43	(+)0.20
29	**1128**	**3**	**81.87**	**81.87**	**26.74**	**24.18**	**(+)2.56**
30	**1133**	**3**	**81.87**	**81.87**	**16.21**	**16.59**	**(-)0.38**
31	1137	3	81.82	81.82	7.79	7.71	(+)0.08
32	1141	3	81.88	81.88	6.20	5.83	(+)0.37
33	1142	3	81.77	81.77	0.98	0.94	(+)0.04
34	1143	3	81.85	81.85	0.76	0.51	(+)0.25
35	1144	3	81.78	81.78	7.36	7.29	(+)0.07

36	1145	3	81.77	81.77	1.51	1.35	(+)0.16
37	**1146**	**3**	**81.87**	**81.87**	**10.61**	**10.85**	**(-)0.24**
38	1147	3	81.77	81.77	4.10	4.44	(-)0.34
39	1148	3	81.78	81.78	1.69	1.33	(+)0.36
40	1149	3	81.77	81.77	7.86	6.99	(+)0.87
41	1150	3	81.79	81.79	5.21	4.87	(+)0.34
42	1151	3	81.78	81.78	2.05	0.51	(+)1.54
43	1152	3	81.77	81.77	0.89	0.74	(+)0.15
44	**1153**	**3**	**81.93**	**81.93**	**76.78**	**76.46**	**(+)0.32**
45	1154	3	81.79	81.79	1.06	0.71	(+)0.35
46	**1155**	**3**	**81.82**	**81.82**	**18.39**	**17.13**	**(+)1.26**
47	**1156**	**3**	**81.89**	**81.89**	**11.44**	**11.44**	**-------**
48	1157	3	81.84	81.84	3.00	2.85	(+)0.15
49	1158	3	81.80	81.80	1.98	2.45	(-)0.47
50	1159	3	81.81	81.81	0.88	0.64	(+)0.24
51	1161	3	81.91	81.91	1.07	1.08	(-)0.01
52	1162	3	81.85	81.85	0.77	0.6	(+)0.17
53	1163	3	81.84	81.84	0.82	0.6	(+)0.22
54	**1164**	**3**	**81.84**	**81.84**	**15.13**	**15.32**	**(-)0.19**
55	1165	3	81.85	81.85	4.64	4.6	(+)0.04
56	1166	3	81.83	81.83	0.46	0.72	(-)0.26
57	1167	3	81.82	81.82	0.85	0.9	(-)0.05
58	1168	3	81.83	81.83	3.85	4.19	(-)0.34
59	1395	3	81.41	81.41	2.15	2.06	(+)0.09
60	1443	3	81.76	81.76	2.32	2.73	(-)0.41
61	1445	3	81.72	81.72	9.44	9.13	(+)0.31
62	1446	3	81.72	81.72	0.77	0.79	(-)0.02
63	1447	3	81.73	81.73	1.28	1	(+)0.28
64	**1453**	**3**	**81.54**	**81.54**	**10.72**	**10.42**	**(+)0.30**
65	1454	3	81.54	81.54	4.59	5.35	(-)0.76
66	1455	3	81.55	81.55	1.46	1.57	(-)0.11
67	1456	3	81.55	81.55	1.28	1.27	(+)0.01
68	1457	3	81.56	81.56	1.59	1.89	(-)0.30
69	1458	3	81.55	81.55	2.36	2.19	(+)0.17
70	1460	3	81.53	81.53	0.77	1.13	(-)0.36
71	1462	3	81.52	81.52	1.87	2.6	(-)0.73
72	1463	3	81.51	81.51	1.43	1.45	(-)0.02
73	1467	3	81.49	81.49	1.09	1.05	(+)0.04
74	1468	3	81.50	81.50	1.12	1.27	(-)0.15
75	1469	3	81.50	81.50	1.13	1.16	(-)0.03

76	1470	3	81.50	81.50	9.92	8.44	(+)1.48
77	1471	3	81.51	81.51	4.53	4.49	(+)0.04
78	1472	3	81.50	81.50	6.70	7.15	(-)0.45
79	1473	3	81.48	81.48	2.97	2.27	(+)0.70
80	1475	3	81.43	81.43	1.76	2.88	(-)1.12
81	1476	3	81.42	81.42	1.23	1.56	(-)0.33
82	1479	3	81.42	81.42	2.92	2.6	(+)0.32
83	1480	3	81.41	81.41	1.53	1.47	(+)0.06
84	1481	3	81.42	81.42	1.87	2.53	(-)0.66
85	1482	3	81.43	81.43	4.37	5.21	(-)0.84
86	1483	3	81.42	81.42	6.47	5.79	0.68
87	1484	3	81.41	81.41	1.81	2.18	(-)0.37
88	1485	3	81.41	81.41	1.71	1.55	(+)0.16
89	1486	3	81.41	81.41	1.25	1.27	(-)0.02
90	1487	3	81.40	81.40	4.99	5.5	(-)0.51
91	1488	3	81.38	81.38	9.77	9.62	(+)0.15
92	1493	3	81.26	81.26	0.58	0.57	(+)0.01
93	1495	3	81.23	81.23	4.23	3.9	(+)0.33
94	1495	3	81.55	81.55	7.88	8.03	(-)0.15
95	1496	3	81.21	81.21	1.46	1.28	(+)0.18
96	1497	3	81.20	81.20	0.61	0.71	(-)0.10
97	1499	3	81.23	81.23	5.67	6.49	(-)0.82
98	1501	3	81.23	81.23	0.65	0.67	(-)0.02
99	1502	3	81.23	81.23	0.87	0.63	(+)0.24
100	1503	3	81.23	81.23	0.58	0.44	(+)0.14
101	1505	3	81.22	81.22	2.58	2.74	(-)0.16
102	1508	3	81.22	81.22	2.61	2.76	(-)0.15
103	1509	3	81.20	81.20	0.92	1.01	(-)0.09
104	**1510**	**3**	**81.19**	**81.19**	**55.88**	**54.97**	**(+)0.91**
105	1511	3	81.18	81.18	1.78	2.29	(-)0.51
106	**1512**	**3**	**81.15**	**81.15**	**22.70**	**23.17**	**(-)0.47**
107	1513	3	81.14	81.14	0.65	1.09	(-)0.44
108	1516	3	81.13	81.13	0.70	1.09	(-)0.39
109	**1518**	**3**	**81.15**	**81.15**	**12.18**	**14.98**	**(-)2.80**
110	1519	3	81.15	81.15	1.17	1.6	(-)0.43
111	1520	3	81.15	81.15	1.58	1.19	(+)0.39
112	1524	3	81.13	81.13	0.73	0.72	(+)0.01
113	1525	3	81.13	81.13	1.32	1.82	(-)0.50
114	1526	3	81.14	81.14	2.42	2.15	(+)0.27
115	**1527**	**3**	**81.14**	**81.14**	**11.60**	**12.34**	**(-)0.74**

116	**1528**	**3**	**81.14**	**81.14**	**10.29**	**10.62**	**(-)0.33**
117	1529	3	81.13	81.13	3.49	3.21	(+)0.28
118	1530	3	81.12	81.12	4.07	4.22	(-)0.15
119	1531	3	81.13	81.13	0.73	0.73	-------
120	1532	3	81.12	81.12	4.66	4.87	(-)0.21
121	1533	3	81.12	81.12	2.49	2.36	(+)0.13
122	1534	3	81.11	81.11	4.29	3.88	(+)0.41
123	1535	3	81.08	81.08	2.09	2.11	(-)0.02
124	1537	3	81.09	81.09	6.11	7.99	(-)1.88
125	1538	3	81.11	81.11	1.84	2.15	(-)0.31
126	1539	3	81.10	81.10	4.37	4.14	(+)0.23
127	1542	3	81.08	81.08	5.03	6.23	(-)1.20
128	1545	3	81.05	81.05	1.09	0.71	(+)0.38
129	1546	3	81.05	81.05	0.95	0.53	(+)0.42
130	1547	3	81.03	81.03	5.84	6.65	(-)0.81
131	**1548**	**3**	**81.03**	**81.03**	**16.98**	**17.21**	**(-)0.23**
132	1549	3	81.03	81.03	2.65	3.31	(-)0.66
133	1550	3	81.01	81.01	2.74	3.05	(-)0.31
134	1551	3	81.01	81.01	0.57	1	(-)0.43
135	1552	3	81.13	81.13	4.73	5.39	(-)0.66
136	1553	3	81.14	81.14	1.44	1.21	(+)0.23
137	1554	3	81.26	81.26	1.99	1.64	(+)0.35
138	1562	3	81.82	81.82	1.88	1.59	(+)0.29
139	1564	3	81.84	81.84	3.70	4.29	(-)0.59
140	**1565**	**3**	**81.85**	**81.85**	**19.20**	**18.33**	**(+)0.87**
141	1744	3	81.00	81.00	0.80	0.86	(-)0.06
142	1745	3	81.02	81.02	1.75	1.32	(+)0.43
143	1753	3	81.32	81.32	1.29	1.09	(+)0.20
144	1754	3	81.32	81.32	0.60	0.34	(+)0.26
145	1754	3	81.48	81.48	0.59	0.48	(+)0.11
146	1755	3	81.33	81.33	1.51	2.29	(-)0.78
147	1756	3	81.46	81.46	0.57	0.91	(-)0.34
148	1777	3	81.46	81.46	2.93	3.46	(-)0.53
149	1778	3	81.47	81.47	0.93	1.02	(-)0.09
150	1779	3	81.47	81.47	0.75	1.09	(-)0.34
151	1781	3	81.48	81.48	3.06	2.99	(+)0.07
152	1809	3	81.92	81.92	0.69	0.67	(+)0.02
153	2172	3	81.16	81.16	0.33	0.67	(-)0.34
154	2173	3	81.14	81.14	8.12	7.52	(+)0.60
155	2174	3	81.17	81.17	1.29	1.44	(-)0.15

156	2175	3	81.39	81.39	8.90	8.90	-------
157	2176	3	81.47	81.47	0.45	0.45	-------
158	2177	3	81.52	81.52	0.88	1.28	(-)0.40
159	2179	3	81.67	81.67	4.59	4.29	(+)0.30
160	**2180**	**3**	**81.85**	**81.85**	**27.39**	**24.28**	**(+)3.11**
161	2182	3	81.91	81.91	1.94	1.63	(+)0.31
162	2184	3	81.81	81.81	0.59	0.36	(+)0.23
163	2185	3	81.78	81.78	0.99	0.34	(+)0.65
164	2187	3	81.77	81.77	5.02	4.1	(+)0.92
165	2190	3	80.95	80.95	0.75	0.64	(+)0.11
166	2191	3	80.95	80.95	2.37	1.07	(+)1.30
167	2193	3	81.09	81.09	0.74	0.73	(+)0.01
168	2194	3	81.48	81.48	0.52	0.52	(+)0.00
169	2195	3	81.41	81.41	2.25	2.33	(-)0.08
170	7029	3	81.40	81.40	0.29	0.31	(-)0.02
171	7035	3	81.48	81.48	0.44	0.64	(-)0.20
172	7037	3	81.48	81.48	0.41	0.61	(-)0.20
173	7040	3	81.70	81.70	1.22	0.88	(+)0.34
174	7042	3	81.75	81.75	0.46	0.25	(+)0.21
175	7043	3	81.76	81.76	0.66	0.3	(+)0.36
176	7055	3	81.49	81.49	0.76	0.45	(+)0.31
177	7060	3	81.37	81.37	0.87	0.54	(+)0.33
178	7064	3	81.31	81.31	0.46	0.55	(-)0.09
179	7066	3	81.30	81.30	1.90	1.8	(+)0.10
180	7067	3	81.25	81.25	0.47	0.46	(+)0.01
181	7071	3	81.21	81.21	0.65	0.69	(-)0.04
182	7074	3	81.11	81.11	1.30	1.25	(+)0.05
183	7075	3	81.09	81.09	0.64	0.47	(+)0.17
184	7076	3	81.09	81.09	0.49	0.37	(+)0.12
185	7079	3	81.07	81.07	0.64	0.64	(+)0.00
186	7080	3	81.07	81.07	0.51	0.5	(+)0.01
187	7081	3	81.07	81.07	0.69	0.69	-------
188	7089	3	81.80	81.80	0.19	0.19	-------
189	7090	3	81.85	81.85	0.92	0.8	(+)0.12
190	9327	3	80.97	80.97	0.81	0.71	(+)0.10
191	9329	3	81.13	81.13	0.59	1.41	(-)0.82
192	9330	3	81.16	81.16	10.00	5.65	(+)4.35
193	9331	3	81.16	81.16	0.46	0.28	(+)0.18
194	9334	3	81.19	81.19	0.49	0.5	(-)0.01
195	9335	3	81.19	81.19	1.14	0.95	(+)0.19

196	9336	3	81.18	81.18	1.93	2	(-)0.07
197	9337	3	81.22	81.22	1.58	1.57	(+)0.01
198	**9338**	**3**	**81.22**	**81.22**	**10.04**	**10.92**	**(-)0.88**
199	9339	3	81.23	81.23	0.93	0.66	(+)0.27
200	9340	3	81.23	81.23	0.23	0.21	(+)0.02
201	9341	3	81.22	81.22	2.65	2.2	(+)0.45
202	9342	3	81.26	81.26	1.32	1.37	(-)0.05
203	9343	3	81.28	81.28	8.06	9.3	(-)1.24
204	9344	3	81.26	81.26	4.48	4.94	(-)0.46
205	9346	3	81.32	81.32	0.49	0.48	(+)0.01
206	9348	3	81.35	81.35	0.41	0.46	(-)0.05
207	9349	3	81.37	81.37	1.03	1.17	(-)0.14
208	9351	3	81.44	81.44	0.54	0.53	(+)0.01
209	9354	3	81.51	81.51	4.62	3.63	(+)0.99
210	9355	3	81.52	81.52	1.50	0.72	(+)0.78
211	9356	3	81.51	81.51	1.10	1.22	(-)0.12
212	9357	3	81.89	81.89	4.93	4.7	(+)0.23
213	9358	3	81.89	81.89	6.12	5.59	(+)0.53
214	9359	3	81.90	81.90	0.71	0.48	(+)0.23
215	9361	3	81.43	81.43	1.58	1.95	(-)0.37
216	9362	3	81.47	81.47	0.72	0.7	(+)0.02
217	9363	3	81.46	81.46	0.30	0.33	(-)0.03
218	9364	3	81.47	81.47	0.49	0.61	(-)0.12
219	9365	3	81.48	81.48	0.29	0.51	(-)0.22
220	9368	3	81.75	81.75	0.23	0.3	(-)0.07
221	9369	3	81.82	81.82	0.65	0.56	(+)0.09
222	9370	3	81.99	81.99	3.83	3.84	(-)0.01
223	9371	3	81.17	81.17	0.51	0.47	(+)0.04
224	9372	3	81.17	81.17	1.06	1.07	(-)0.01
225	9374	3	81.53	81.53	0.41	0.25	(+)0.16
226	9375	3	81.50	81.50	0.74	0.61	(+)0.13
227	10294	3	82.16	82.16	5.87	5.74	(+)0.13
228	10295	3	82.12	82.12	2.07	1.41	(+)0.66
229	10296	3	82.06	82.06	1.63	1.47	(+)0.16
230	10297	3	82.06	82.06	0.47	0.46	(+)0.01
231	10298	3	82.05	82.05	0.35	0.26	(+)0.09
232	10299	3	82.04	82.04	0.36	0.27	(+)0.09
233	10300	3	82.04	82.04	1.11	0.86	(+)0.25
234	10301	3	82.03	82.03	1.28	0.78	(+)0.50
235	10302	3	82.04	82.04	0.68	0.25	(+)0.43

236	10303	3	82.01	82.01	1.29	1.39	(-)0.10
237	10305	3	81.93	81.93	0.43	0.88	(-)0.45
238	10307	3	81.87	81.87	1.81	1.07	(+)0.74
239	10308	3	81.86	81.86	0.58	0.31	(+)0.27
240	10311	3	81.81	81.81	0.23	0.36	(-)0.13
241	10312	3	81.81	81.81	0.23	0.21	(+)0.02
242	10313	3	81.78	81.78	1.15	1.06	(+)0.09
243	10314	3	81.79	81.79	0.58	0.57	(+)0.01
244	10315	3	81.79	81.79	0.76	0.38	(+)0.38
245	10316	3	81.74	81.74	1.02	1.19	(-)0.17
246	10317	3	81.71	81.71	0.80	0.69	(+)0.11
247	10318	3	81.71	81.71	0.41	0.3	(+)0.11
248	10320	3	81.70	81.70	1.22	0.73	(+)0.49
249	10321	3	81.44	81.44	0.43	0.42	(+)0.01
250	10332	3	81.14	81.14	1.27	1.11	(+)0.16
251	10334	3	81.25	81.25	0.57	0.63	(-)0.06
252	10336	3	81.25	81.25	1.38	1.65	(-)0.27
253	10343	3	81.52	81.52	2.96	3.36	(-)0.40
254	10344	3	81.53	81.53	10.32	8.48	(+)1.84
255	10345	3	81.55	81.55	5.01	4.29	(+)0.72
256	10346	3	81.70	81.70	2.32	2.53	(-)0.21
257	10350	3	81.98	81.98	4.41	4.26	(+)0.15
258	**10357**	**3**	**81.13**	**81.13**	**14.66**	**----------**	----------
259	10358	3	81.53	81.53	6.12	----------	----------
260	10359	3	81.23	81.23	3.87	----------	----------
261	10360	3	81.73	81.73	1.71	----------	----------
262	10361	3	81.23	81.23	0.65	----------	----------
263	10362	3	81.14	81.14	1.67	----------	----------
264	10363	3	81.75	81.75	2.24	----------	----------
265	10364	3	81.51	81.51	0.12	----------	----------
266	10365	3	82.21	82.21	8.29	----------	----------
267	10366	3	81.82	81.82	1.37	----------	----------
268	10367	3	81.53	81.53	1.78	----------	----------
269	10368	3	81.21	81.21	2.08	----------	----------
270	10369	3	81.20	81.20	1.80	----------	----------
271	10370	3	81.20	81.20	0.51	----------	----------
272	10371	3	81.41	81.41	3.92	----------	----------
273	10372	3	81.50	81.50	2.05	----------	----------
274	10373	3	82.24	82.24	2.47	----------	----------
275	10374	3	82.25	82.25	0.94	----------	----------
276	10375	3	81.97	81.97	2.08	----------	----------

277	10376	3	81.95	81.95	2.01	----------	----------
278	10378	3	81.91	81.91	1.61	----------	----------
279	10379	3	81.91	81.91	0.61	----------	----------
280	10380	3	81.88	81.88	2.41	----------	----------
281	10381	3	81.88	81.88	0.51	----------	----------
282	10382	3	81.86	81.86	0.43	----------	----------
283	10383	3	81.50	81.50	0.48	----------	----------
284	10384	3	82.17	82.17	2.43	----------	----------
285	10385	3	82.36	82.36	2.51	----------	----------
286	**10386**	**3**	**80.94**	**80.94**	**30.67**	----------	----------
287	10292HWL	3	82.03	82.03	1.10	0.93	(+)0.17
288	10293HWL	3	82.18	82.18	3.29	2.34	(+)0.95
289	1031HWL	3	81.52	81.52	2.21	1.97	(+)0.24
290	10327HWL	3	81.22	81.22	2.81	2.38	(+)0.43
291	**1039HWL**	**3**	**81.70**	**81.70**	**11.65**	**10.34**	**(+)1.31**
292	1074HWL	3	81.23	81.23	1.68	1.63	(+)0.05
293	1075HWL	3	81.23	81.23	2.42	2.68	(-)0.26
294	1088HWL	3	81.54	81.54	2.32	2.73	(-)0.41
295	**1092HWL**	**3**	**81.56**	**81.56**	**10.23**	**12.85**	**(-)2.62**
296	**1093HWL**	**3**	**82.13**	**82.13**	**5988.80**	**5966.5**	**(+)22.30**
297	**1094HWL**	**3**	**82.07**	**82.07**	**15.90**	**14.37**	**(+)1.53**
298	**1095HWL**	**3**	**82.08**	**82.08**	**18.23**	**15.69**	**(+)2.54**
299	1122HWL	3	81.82	81.82	0.80	0.53	(+)0.27
300	1123HWL	3	81.82	81.82	0.76	0.56	(+)0.20
301	1124HWL	3	81.82	81.82	5.22	5.17	(+)0.05
302	1136HWL	3	81.78	81.78	9.11	8.87	(+)0.24
303	1139HWL	3	81.80	81.80	2.86	3.22	(-)0.36
304	**1349HWL**	**3**	**81.57**	**81.57**	**348.91**	**323.66**	**(+)25.24**
305	1355HWL	3	81.55	81.55	1.61	1.44	(+)0.17
306	1358HWL	3	81.55	81.55	1.38	1.47	(-)0.09
307	1359HWL	3	81.54	81.54	4.50	4.50	--------
308	1376HWL	3	81.24	81.24	1.59	1.33	(+)0.26
309	1377HWL	3	81.24	81.24	0.46	0.31	(+)0.15
310	1383HWL	3	81.21	81.21	2.00	1.72	(+)0.28
311	**138HWL**	**3**	**81.23**	**81.23**	**25795.60**	**25710.72**	**(+)84.88**
312	**145HWL**	**3**	**81.47**	**81.47**	**41845.10**	**41517.06**	**(+)328.04**
313	**1557RS**	**3**	**81.17**	**81.17**	**71.73**	**71.15**	**(+)0.58**
314	1566HWL	3	82.03	82.03	4.82	5.26	(-)0.44
315	**1772RS**	**3**	**81.09**	**81.09**	**19.68**	**13.73**	**(+)5.95**
316	1773RS	3	81.11	81.11	2.62	2.45	(+)0.17
317	1775RS	3	81.13	81.13	5.61	5.57	(+)0.04

318	**1782HWL**	**3**	**81.74**	**81.74**	**41.06**	**30.34**	**(+)10.72**
319	1784HWL	3	81.71	81.71	2.86	3.28	(-)0.42
320	1786HWL	3	81.75	81.75	1.08	0.53	(+)0.55
321	1787HWL	3	82.12	82.12	2.00	1.75	(+)0.25
322	1788HWL	3	82.12	82.12	1.99	2	(-)0.01
323	205HWL	3	81.57	81.57	7.07	6.2	(+)0.87
324	207HWL	3	81.55	81.55	5.74	5.86	(-)0.12
325	208HWL	3	81.55	81.55	3.31	2.4	(+)0.91
326	**210HWL**	**3**	**81.55**	**81.55**	**59.40**	**57.41**	**(+)1.99**
327	211HWL	3	81.71	81.71	2.02	1.73	(+)0.29
328	2157HWL	3	81.52	81.52	0.50	0.25	(+)0.25
329	2158HWL	3	81.51	81.51	0.65	0.6	(+)0.05
330	2159HWL	3	81.51	81.51	0.30	0.3	(+)0.00
331	2160HWL	3	81.51	81.51	0.46	0.46	(+)0.00
332	2161HWL	3	81.50	81.50	1.62	0.92	(+)0.70
333	2163HWL	3	81.50	81.50	0.43	0.32	(+)0.11
334	2165HWL	3	81.55	81.55	0.48	0.5	(-)0.02
335	2166HWL	3	81.55	81.55	0.24	0.24	(+)0.00
336	**2167HWL**	**3**	**81.58**	**81.58**	**101.76**	**99.15**	**(+)2.61**
337	**2169HWL**	**3**	**81.19**	**81.19**	**11.38**	**11.29**	**(+)0.09**
338	2170RS	3	81.11	81.11	2.92	2.32	(+)0.60
339	2196HWL	3	81.52	81.52	0.60	0.31	(+)0.29
340	257HWL	3	81.57	81.57	2.02	1.96	(+)0.06
341	385HWL	3	81.54	81.54	7.58	3.88	(+)3.70
342	7047HWL	3	81.69	81.69	0.52	0.7	(-)0.18
343	7088HWL	3	81.76	81.76	4.37	4.39	(-)0.02
344	9360hwl	3	81.24	81.24	0.47	0.57	(-)0.10
345	9367hwl	3	81.69	81.69	0.45	0.32	(+)0.13
346	960HWL	3	81.69	81.69	4.33	3.44	(+)0.89
347	961HWL	3	81.69	81.69	2.49	2.3	(+)0.19
348	962HWL	3	81.70	81.70	1.16	0.82	(+)0.34

HWL= High Altitude Wetland
RS= River Section
SG= Supra Glacier lakes

Further analysis of LISS III satellite data, it has been found that in the Upper Satluj Basin is more susceptible for the lake formation may be because of the higher temperature over the higher latitudes and the total number of lakes that could be mapped in Upper Satluj basin varies from 437 (2019) to 707 (2020) to 588(2021) to 639 (2022) to 681 (2023) which indicates an increase of 244 lakes w.r.t. 2019, reduction of 26 lakes w.r.t 2020 and further enhancement of 93 lakes w.r.t 2021, 42 lakes w.r.t 2022 or in other words we can say that the increase is of the order of about 36 % with reference to 2019 and about 4% decrease with reference to 2020, and again increase 14% in comparison to 2021, 7% increase w.r.t. 2022 respectively is observed as far as the total number of lakes based on LISS III satellite data in case of Upper Satluj basin is concerned (Fig: 7.5) and the small variation observed could be due to non-availability of the good quality snow free and cloud free data coverage based on LISS III satellite data.

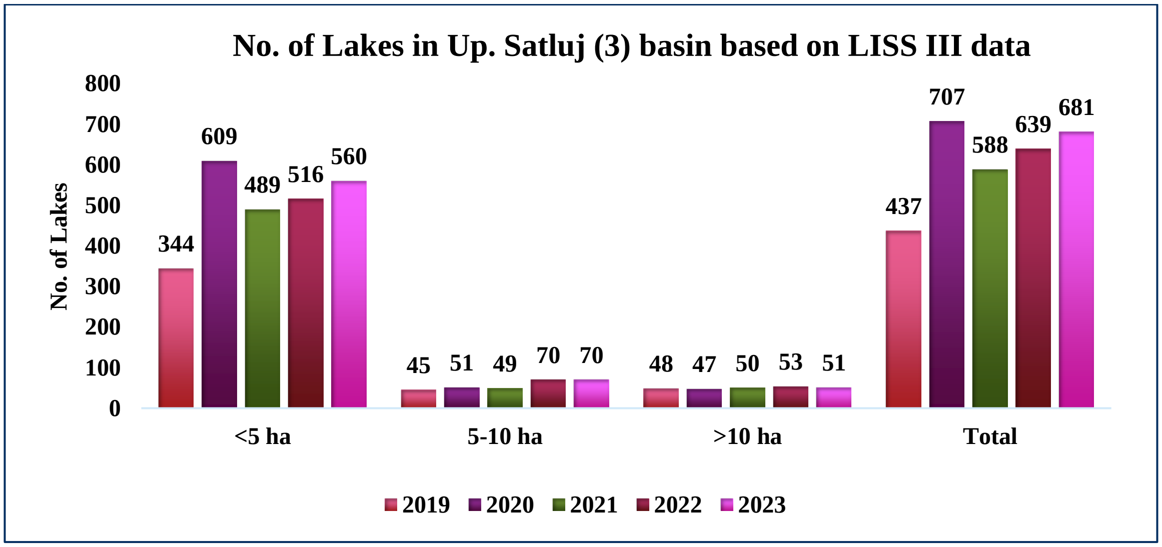


Fig. 7.5: No. of Lakes in Upper Satluj (3) basin based on LISS III data

Likewise in Lower Satluj basin, total number of lakes mapped varies from 52 (2019) to 89 (2020) to 163 (2021) to 173 (2022) to 182 (2023) reflecting a gradual increasing trend of lake formations in Lower Satluj basin with an overall increase of 130 lakes (about 71%) w.r.t 2019, 93 lakes (51%) w.r.t 2020, 19 lakes (about 10%) w.r.t 2021 and 9 Lakes (about 5%) w.r.t. to 2022 based on the results obtained from LISS III satellite data analysis (Fig: 7.6).

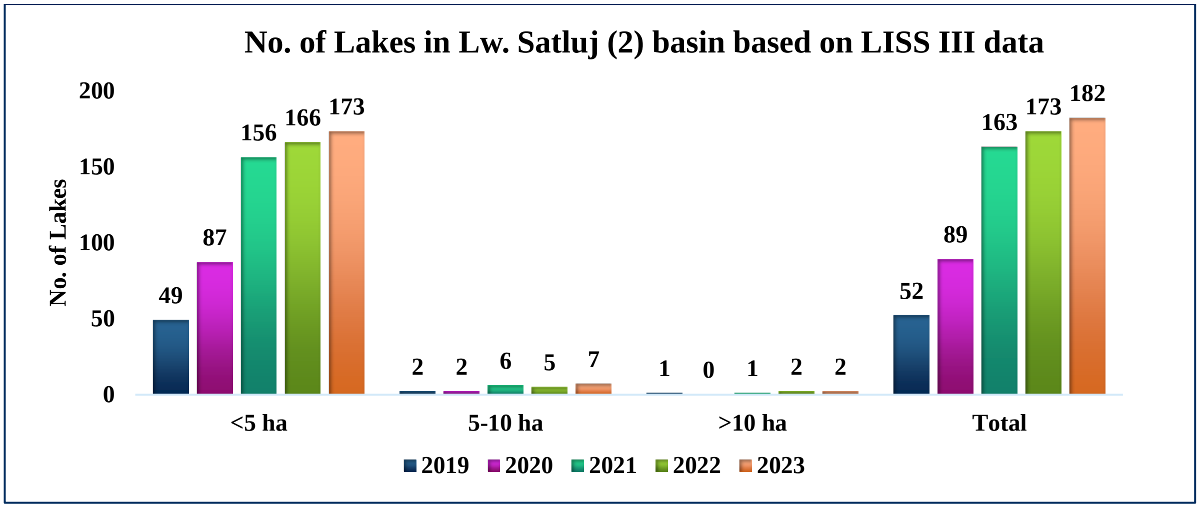


Fig. 7.6: No. of Lakes in Lower Satluj (2) basin based on LISS III data

Similarly, in Spiti basin the total number of lakes mapped varies from 73 (2019) to 197 (2020) to 129 (2021) to 183(2022) to 185 (2023) with an overall increase of about 61% (112 lakes) w.r.t to 2019, decrease of about 6% (12 lakes) w.r.t. to 2020 and further increase of about 30% (56 Lakes) w.r.t. to 2021 and 1.08% (2 Lakes) w.r.t. to 2022 respectively (Fig: 7.7) and the difference is mainly due to the data quality which is either due to snow cover or cloud cover impacts.

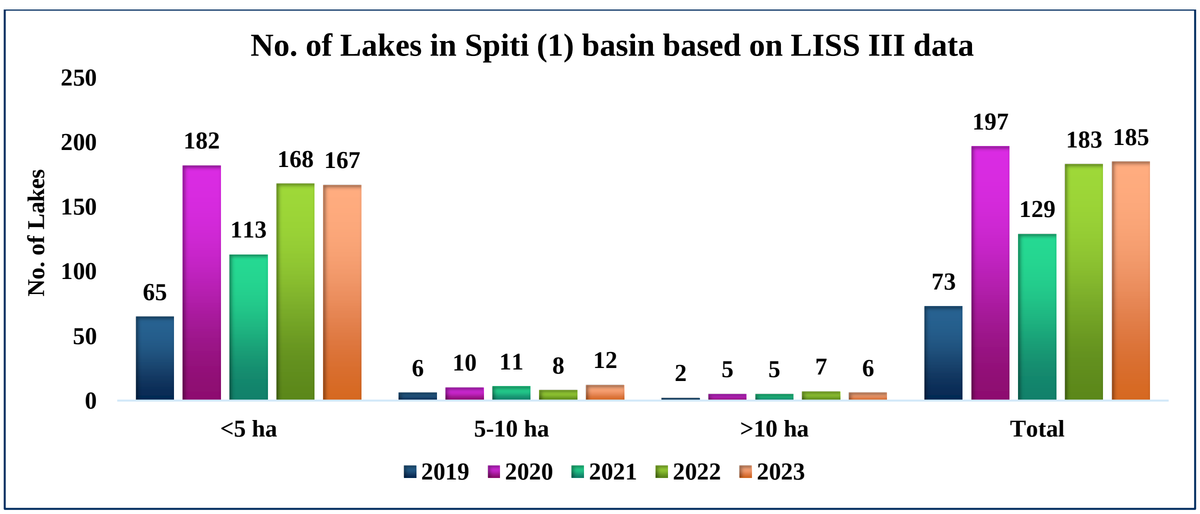


Fig. 7.7: No. of Lakes in Spiti (1) basin based on LISS III data

Further analysing 1048 lakes/wetlands mapped in the entire Satluj basin from LISS-III satellite data in 2023, it is observed that the total number of lakes/wetlands with area more than 10 ha varies from 50 (2019) to 48 (2020) to 52 (2021) 62 (2022) and 59 (2023). Likewise, the total number of lakes with area less than 5ha varies from 458(2019) to 878(2020) to 758(2021) to 850(2022) to 900 (2023) indicating an enhancement of 442 lakes w.r.t. 2019, 22 lakes w.r.t. 2020, 142 lakes w.r.t. 2021 and 50 lakes w.r.t. 2022 respectively. Likewise, the total number of lakes within the aerial range of 5-10 ha varies from 53(2019 to 63(2020) to 66(2021) to 83(2022) to 89 in 2023 indicating an enhancement of 6 lakes w.r.t. 2022), 23 lakes w.r.t. 2021, 26 lakes w.r.t. 2020 and 28 lakes w.r.t. 2019 respectively. Similarly based on LISS-III products in 2023, the total number of lakes with area more than 10ha shows decrease of 3 lakes w.r.t. 2022 (62), an increase of 7 lakes w.r.t. 2021 (52), an increase of 11 lakes w.r.t. 2020(48) and 9 lakes w.r.t. 2019 (50) in comparison to 59 lakes in 2023 respectively. The variation in the number of lakes with reference to the preceding years if any is mainly due to the non-availability of cloud free satellite data covering the entire catchment. Hence these small dimensional lakes/water bodies can be future vulnerable sites and thus needs proper monitoring using higher resolution satellite data for better management. The lakes with ids RS are the lakes formed along the small river section due to debris coverer along the river course on the left bank of Spiti River are the vulnerable locations formed due to temporary damming along the stream course and thus needs monitoring.

8. BASIN WISE COMPARATIVE ANALYSIS

Based on the analysis of satellite data for AWiFS and LISS III sensors during 2023 and the comparative analysis on the basis of result obtained with that of results obtained from 2022, the total number of lakes and the lakes with area more than 10ha in each basin i.e., Spiti basin (Basin 1), Lower Satluj basin (Basin 2) and Upper Satluj Basin (Basin 3) has been seen temporally for each basin. Based on the AWiFS satellite data analysis from April to November 2023 (Fig. 8.1) suggest that maximum number of lakes/wetlands that could be delineated in 2023 using AWiFS satellite data having spatial resolution of 56 mts. varies from April (42) to May (38) to June (59) to July (0 no cloud free data) to August (412) to

September (466) to October (417) to November (36) as per Fig. 8.1 & 8.2 and the variation in number is mainly due to exposed area available in the catchment. On analysing further, it is observed that the maximum number of lakes that could be mapped was 466 in the month of September, 2023 in comparison to 414 of September 2022 indicating an overall increase of 52 lakes during 2023 based on AWiFS data product. Basin wise analysis based on AWIFS data reveals that out of 466 lakes mapped in September 2023, the total number of lakes forming part of Spiti basin were 67 in comparison to 58(2022), 58 from the Lower Satluj basin in comparison to 59(2022) and 341 forms part of the Upper Satluj basin in comparison to 297(2022) respectively. However, on analysing the total lakes based on the aerial extent, the total lakes with area more than 10ha has increased from 76 (2022) to 83 (2023), whereas the lakes with aerial range 5-10 ha are 113 in 2023 and <5ha are 270(2023) respectively.

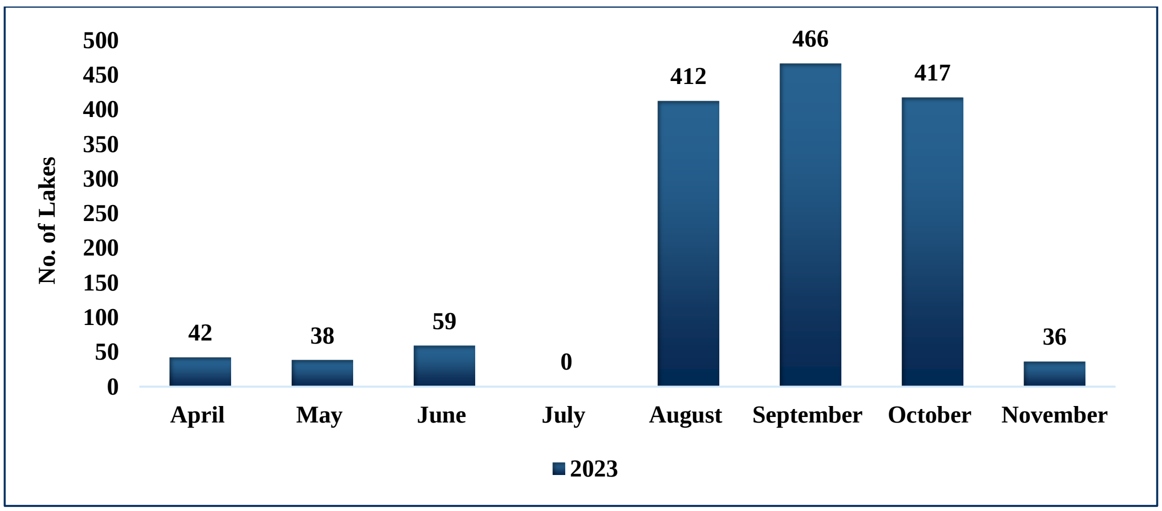


Fig. 8.1: Total No. of Lakes based on AWiFS satellite data, 2023

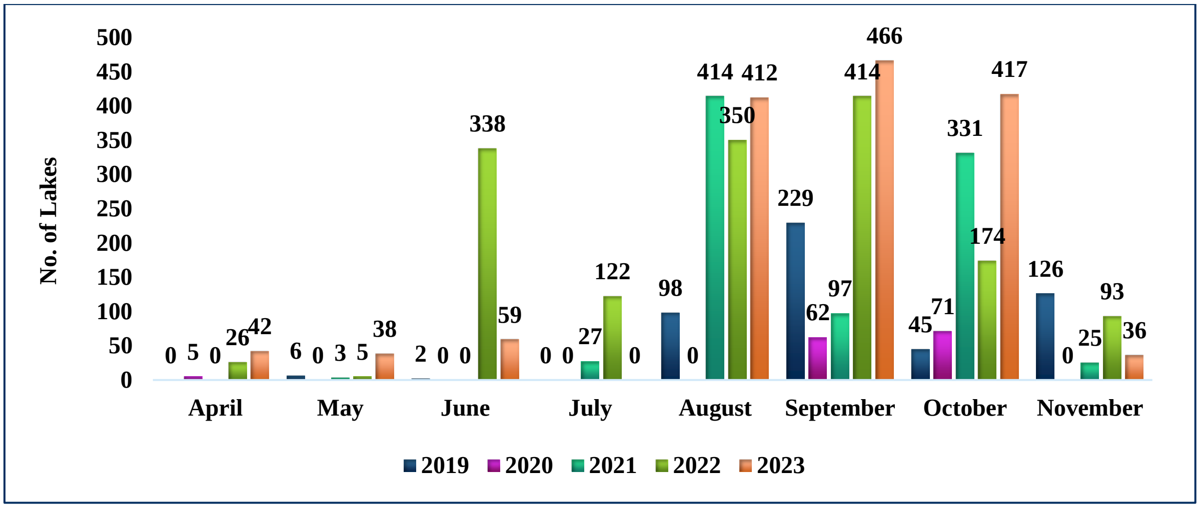


Fig. 8.2: Total No. of Lakes based on AWiFS satellite data 2019, 2020, 2021, 2022 and 2023

The basin wise comparative analysis based on LISS-III satellite data reveals that total number of lakes that could be mapped during 2023 in the Satluj catchment was 1048 in comparison to 995 lakes as mapped in 2022, 880(2021), 993(2020) and 562(2019) respectively. Further in Spiti basin the total number of lakes varies from 73(2019) to 197(2020) to 129(2021) to 183(2022) to 185 (2023) indicating an increase of 1.08% w.r.t 2022, 30 % w.r.t 2021, and decrease of 6% w.r.t 2020 a further an increase of about 61% with that of 2019 and the variation in the numbers is mainly due to the data gap in procuring good quality satellite data with the result the complete information about the catchment could not be retrieved. Likewise in the Lower Satluj basin the total number of lakes varies from 52(2019) to 89(2020) to 163(2021) to 173 (2022) and to182 (2023) reflecting an overall increase of 71% with that of 2019, 51% w.r.t 2020 and 10% w.r.t. 2021 and 5% in 2022 respectively. In Upper Satluj basin, the increase is of the order 36% with that of 2019(437), and a reduction of 4% w.r.t. 2020 (707) and further an increase of 14% w.r.t 2021(588) and 6% w.r.t. 2022 (639) respectively.

Further basin wise comparative analysis reveals that, the Spiti basin shows an increase 2 lakes w.r.t. 2022, 56 lakes w.r.t. 2021, decrease of 12 lakes w.r.t. 2020, and increase of 112 lakes (2019). Further basin wise analysis based on their aerial extent for 2023 reveals that in Spiti basin 167 lakes with area less 5ha, 12 lakes with area between 5-10ha and 6lakes with more than 10ha. Likewise in Lower Satluj basin, total number of lakes/wetlands mapped varies from 52 (2019) to 89 (2020) to 163 (2021) to 173 (2022) and 182 (2023) thus by indicating an increase of about 130 lakes (71%) w.r.t 2019, 93 lakes (about 51%) w.r.t 2020, 19 Lakes (about 10%) w.r.t. 2021 and 9 Lakes (about 5%) w.r.t. 2022. The 182 lakes/wetlands mapped in Lower Satluj basin when classified based on their aerial extent, it comprises of 173 lakes with area less than 5 ha, 7 lakes with area ranging between 5-10 ha and 2 lakes with area more than 10 ha. In Upper Satluj basin the number of lakes mapped varies from 437 (2019) to 707 (2020) to 588(2021) to 639 (2022) to 681 (2023) thus by indicating an increase 244 lakes w.r.t 2019 , reduction of 26 lakes w.r.t. 2020 data and increase of 93 lakes w.r.t. 2021 and 42 lakes w.r.t. 2022 or in other words we can say that the increase is of the order of about 36%, with reference to 2019 and about 4% decrease with reference to 2020 and again an increase by 14% in comparison to 2021 and 6% in comparison to 2022 data is observed respectively and this small variation could be due to non-availability of the good quality snow free and cloud free data coverage based on LISS III satellite data in 2023. The total 681 lakes/wetlands include 560 lakes /wetlands as small one with area less than 5 ha, 70 with area between 5-10 ha and 51 are the big one with area more than 10 ha.

Further comparative analysis of the bigger lakes with area >10 ha based on AWiFS data show an enhancement of 7 lakes in 2023 as compared to 2022 and total number of lakes falling in this category varies 31(2019) to 62 (2020) to 66 (2021) to 76(2022) (Fig. 8.3 & 8.4) out of which 15 are the high-altitude wetlands forming part of the Upper Satluj basin. Further it is found that the Spiti basin the number of lakes with area >10ha that could be mapped varies from 1 (2019) to 7 (2020) to 7 (2021) to 7 (2022) to 6 (2023), in Lower Satluj basin the number of such lakes varies from 0 (2019) to 2 (2020) to 6 (2021) to 6 (2022) to 5 (2023), whereas in Upper Satluj basin the number varies from 30 (2019) to 53 (2020) to 53 (2021) to 63 (2022) to 72 (2023). Likewise, from LISS III data analysis, the number of bigger lakes varies from 19 (2019), 46 (2020), 52 (2020), 62 (2022) to 59 (2023) respectively in the entire study area.

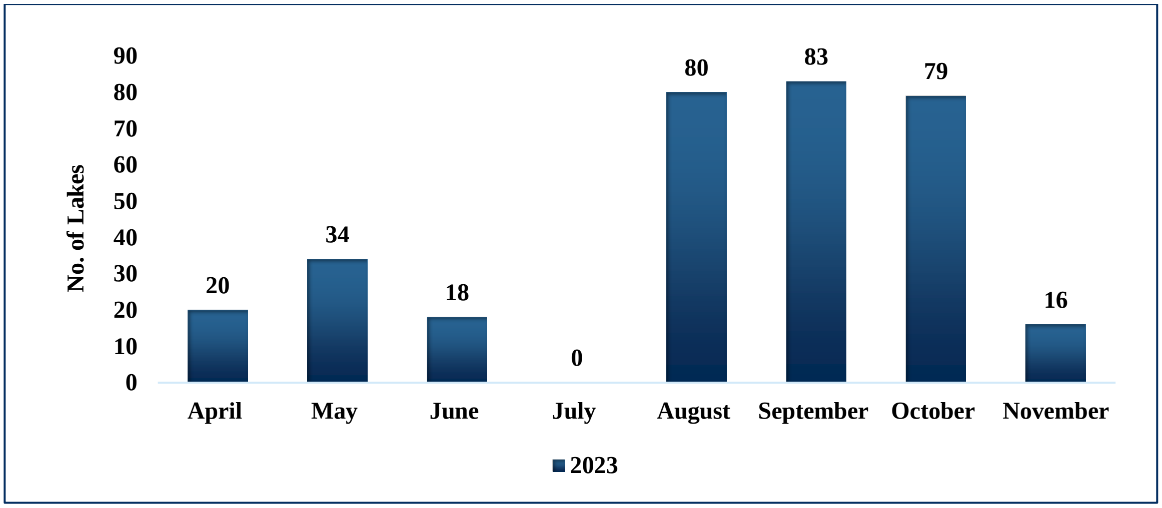


Fig. 8.3: Total No. of Lakes > 10ha based on AWiFS satellite data, 2023

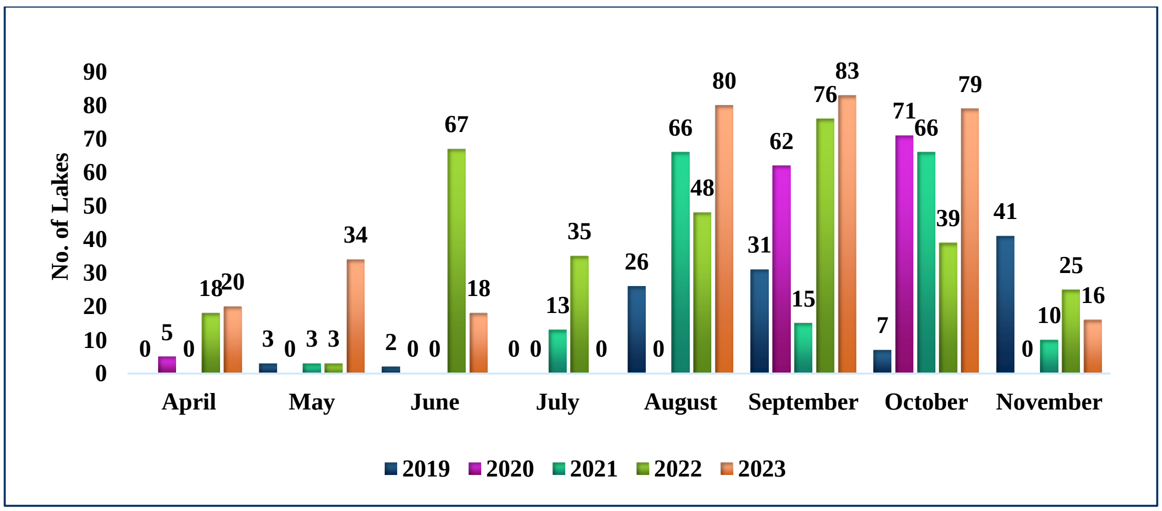


Fig. 8.4: Total No. of Lakes > 10ha based on AWiFS satellite data (2019- 2023)

When the total number of lakes based on AWiFS data are seen w.r.t. 2007 (196) as the base line data, a gradual increase in their number could be seen with some abnormalities in the beginning, whereas a gradual increasing trend could be seen from 2012 onwards and the number varies from 214(2011) to 128 (2012) to 130 (2013) to 192 (2014) to 241 (2015) to 280 (2016) to 280 (2017) to 273(2018) to 229 (2019) to 361 (2020) to 414(2021) to 414 (2022) to 466(2023) (Fig: 8.5) indicating a slight variation in 2018 and 2019. The 466 lakes mapped from AWiFS data during 2023 comprises of 270 lakes/wetlands as small one with area less than 5ha, 113 with area ranging between 5-10ha and 83 as the big one with area more than 10 ha respectively. Further out of 466 lakes mapped in 2023, 39 are the high-altitude wetlands that too from the Upper Satluj basin out of which 15 are with are more than 10 ha, 13 are having area between 5 -10 ha and 11 are smaller one with area less than 5 ha respectively.

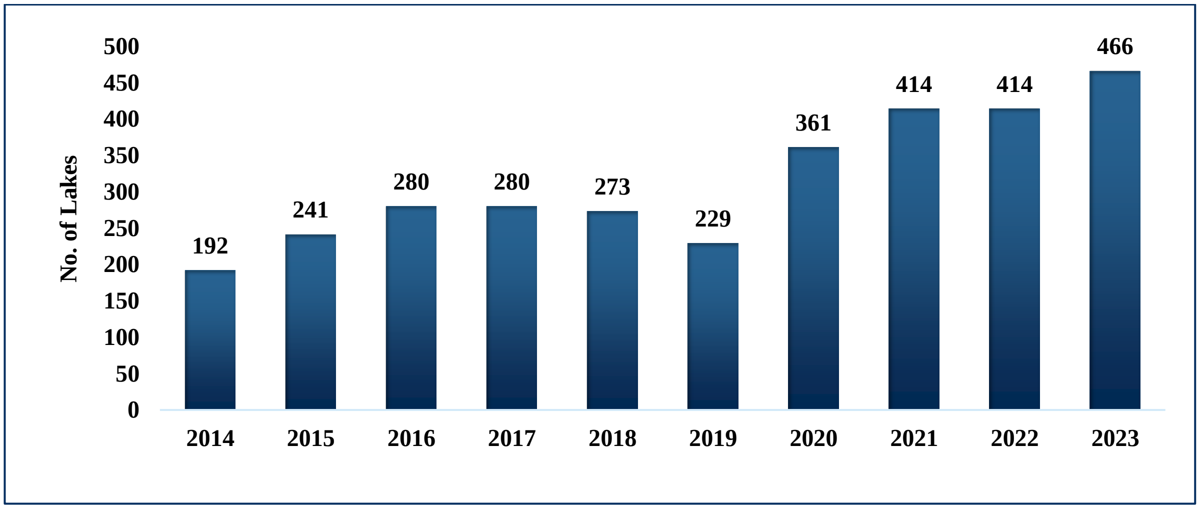


Fig. 8.5: Total Number of Lakes based on AWiFS Data (2014-2023)

From the analysis of high resolution LISS-III satellite data analysis (96/48, 97/48, 97/49, 98/48, 98/49, 99/49 and 100/49), a total of 1048 lakes mapped in 2023 comprises of 900 lakes as the small one with area less 5ha, 89 lakes with area 5-10 ha and 59 lakes with area more than 10 ha (Fig: 8.6 & 8.7). Further as observed from the temporal analysis of LISS III images from 2019 onwards (Fig. 8,7) maximum number of lakes mapped in 2023 from LISS III forms part of the path-row 96/48 & 96/49 (482) (Fig: 8.7) and 99/49 & 100/49 (348) (Fig: 8.7) and the maximum number of forms part of the sub basin 3 i.e., Upper Satluj basin (348) followed by 182 from the Lower Satluj and 185 from the Spiti basins i.e., sub basin 1(Table 8.1).

Table 8.1: Basin wise distribution of total number of lakes in Satluj Catchment during the year 2023 based on LISS III Satellite data interpretation.

Date of Pass	No. of lakes in Basin 1	No. of lakes in Basin 2	No. of lakes in Basin 3	Total No. of lakes (2023)	Total No. of lakes with area >10 ha
96/48 & 96/49	185	182	115	482	13
97/48 & 98/48	0	0	160	160	3
98/49	0	0	58	58	3
99/49 & 100/49	0	0	348	348	40

Further out of 1048 lakes mapped, 66 are mainly the high-altitude wetlands comprising 1 from Spiti basin and 65 from Upper Satluj basin respectively. Further from the comparative analysis of the data obtained from LISS-III images, it is found that the total number of lakes varies from 562 (2019) to 993 (2020) to 880 (2021) to 995 (2022) and 1048 (2023) (Fig:8.7) indicating an overall enhancement of enhancement of 486 lakes with that of 2019 (86%), enhancement of 55 lakes with that of 2020 (5%), enhancement of 168 lakes with that of 2021(19%) and 53 lakes with that of 2022 (5%) respectively (Fig: 8.7). Besides this, the total number of lakes /wetlands with area >10ha based on LISS III data analysis varies from 50(2019), 48(2020), 52(2021), 62(2022) and 59(2023) respectively (Fig.8.8 & 8.9). Further the total variation in the number of lakes mapped in Upper Satluj basin based on LISS III data varies from 437 (2019) to 707 (2020) to 588 (2021) to 639(2022) to 681 (2023) (Fig 7.5), in Lower Satluj basin the number varies from 52 (2019) to 89 (2020) to 163(2021) to (173)2022 to 182(2023) (Fig 7.6) and in case of Spiti sub basin it varies from 73 (2019) to 197 (2020) to 129(2021) to 183 (2022) to 185(2023) (Fig.7.7). In other words, we can say that the Upper Satluj basin reflects an enhancement by about 61% (2019-20), about 16% reduction (2020-21) and again rise by 9% (2021-22) and about 6% (2022-23) and the Lower Satluj basin reflects an enhancement by 71% (2019-20) and further enhancement by 83% (2020-21) and 6% (2021-22) and 6% enhancement between 202-23 could be seen. Likewise, the Spiti basin reflects an enhancement of 169% between 2019-20, 34% reduction between 2020-21 followed by an enhancement of the order of 42% between 2021-22 and 1 % enhancement between 2022-23 could be seen. Further in Spiti basin the lakes with ids 1682RS (1.46ha), 1683RS (8.97ha), 1684RS (2.44ha), 1685RS (0.74ha),1686RS (0.63ha), 1687RS (1.32ha), 9003RS (1.61ha) and 9058RS (0.46ha) and 9207RS (4.74ha) in Lower

Satluj basin lakes which have been mapped along the river sections and shows a fluctuating trend w.r.t the las year water extent. Likewise in Upper Satluj basin, the lakes with ids 1557RS (71.73ha), 1772RS (19.68ha), 1773RS (2.62ha), 1775RS (5.61ha) 2170RS (2.92ha), 101434RS (287.68ha) and 2135RS (6.65) are some of the water bodies which have been developed along the nala sections. All these water bodies are although small but needs monitoring to be (Fig.8.10a and 8.10b). Thus from the above analysis for LISS III for the period 2023, it is clear that although the maximum number of lakes (about 65%) are being formed in the Upper Satluj basin , about 17% in the Lower Satluj basin and about 18% in the Spiti basin of the study area and majority of the lakes (900) delineated in the entire study area during 2023 are small one with area less than 5ha (about 86%) , about 9 % are within 5-10 ha (89 lakes/wetlands) and about 5% with area more than 10ha (59 lakes/wetlands) reflects that the Upper Satluj basin is more susceptible for undergoing climate induced changes resulting to have higher number of such lakes than the Lower Satluj and Spiti basin long with the permafrost conditions which led to the formation of high altitude wetlands in the adjoining Trans Himalayan Region of the Upper Satluj basin.

Thus, to summaries based on the results obtained by using AWiFS and LISS III data products, the results obtained using AWiFS data reflects that the total number of lakes delineated during 2023 has increased from 414 (2022) to 466(2023) reflecting an overall increase of about 13% w.r.t 2022. As far as basin wise distribution for 2023 is concerned, about 14% (67) lakes/wetlands forms part of the Spiti sub basin, 12% (58) of the Lower Satluj basin and 73% (341) forms part of the Upper Satluj basin respectively reflecting an increase of about 15 in Spiti basin, about 2% reduction in Lower Satluj and 15% increase in the Upper Satluj basin in the formation of total number of lakes in 2023 in comparison to 2022. As far as the bigger lakes with area >10ha are concerned, about 25% increase could be seen in 2023(83) in comparison to 2021(66) and about 9% in comparison to 2022 (76) and majority of the lakes (72) forming part of the Upper Satluj basin, 5 from the Lower Satluj basin and 6 from the Spiti basin. Out of 466 lakes, 39 are the high-altitude wetlands and the remaining lakes were from the glacial origin. Likewise, 1048 lakes /wetlands mapped from LISS III images in 2023, indicates an enhancement of 53 lakes/wetlands (5%) in comparison to 2022 comprising about 5% (59) as the big lakes/wetlands with area more than 10ha and about 9% out of which (89) are within aerial range of 5-10ha. The comparative analysis based on LISS-III satellite data reveals that total number of lakes varies from 562 (2019) to 993 (2020) to 880(2021) to 995 (2022) to 1048 (2023) indicating an enhancement of about 76% between 2019-20, further a reduction of about 11% between 2020-21 followed by an enhancement of about 13% between 2021-22 and further enhancement of 5% between 2022-23 respectively. Thus, the data base based on AWiFS data product is reflects a complete inventory of lakes 466 lakes in the Satluj catchment with a coarse resolution (56mts) as the data product used covers the complete study area and also free from the impact of clouds as in September 2023, whereas the LISS-III data products reflect a more detailed inventory of the 1048 lakes of with a set of fine resolution (23.5mts) reflecting more detailed information about the lakes with small dimensions.

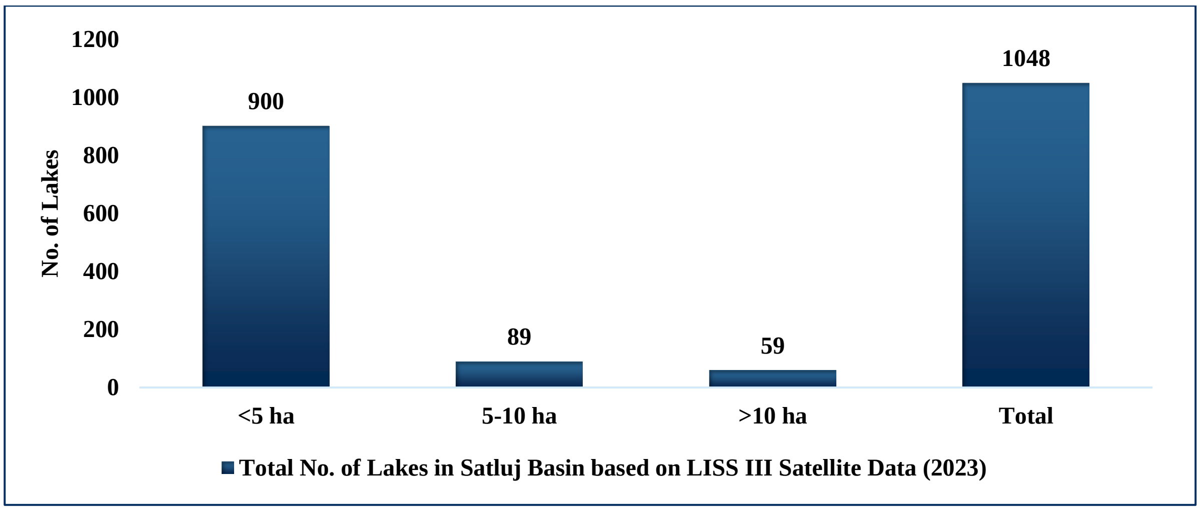


Fig. 8.6: Total No. of Lakes based on LISS III Satellite Data, 2023

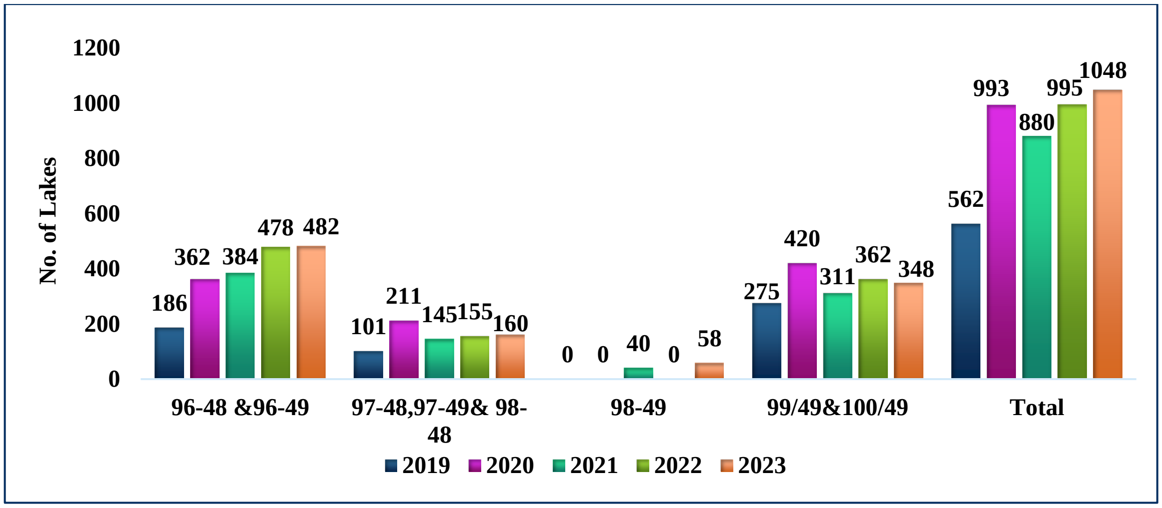


Fig. 8.7: Total No. of Lakes based on LISS III Satellite Data (2019- 2023)

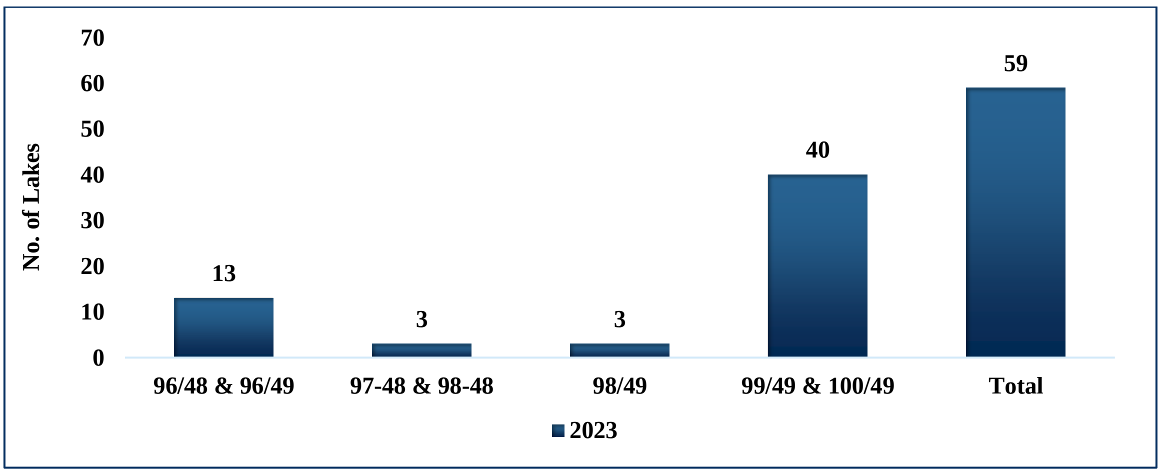


Fig. 8.8: Total No. of Lakes > 10ha based on LISS III Satellite Data 2023

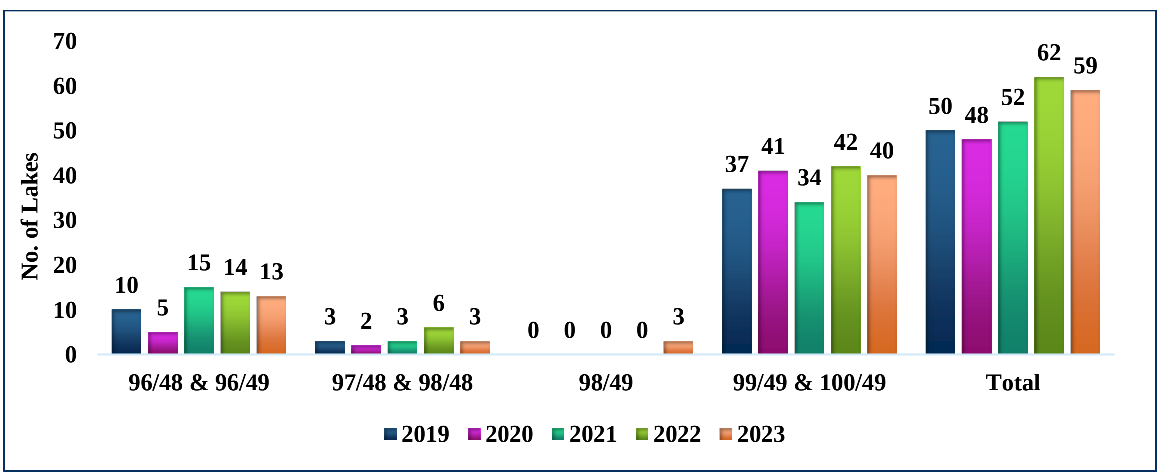


Fig. 8.9: Total No. of Lakes >10ha based on LISS III Satellite Data 2019, 2020, 2021, 2022 and 2023

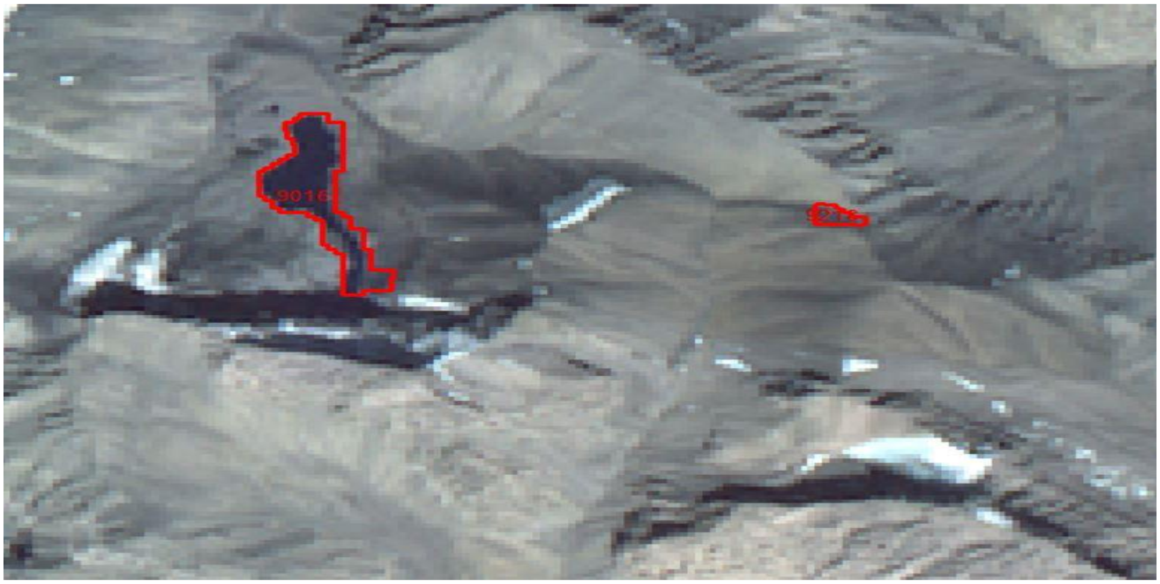


Fig. 8.10 (a): Satellite view, LISS III of water bodies in Spiti basin

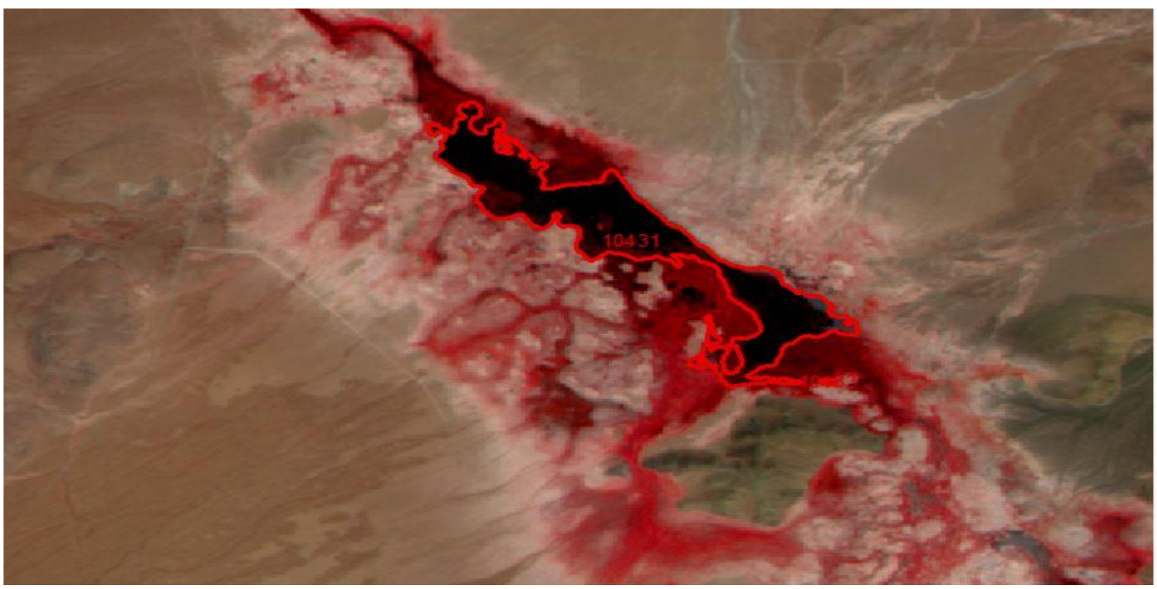


Fig. 8.10 (b): Satellite view, LISS III of water bodies along the River Section in Upper Satluj basin

9. INVENTORY OF LAKES BASED ON LISS -IV SATELLITE DATA FOR 2023

Besides the two datasets generated during 2023 using AWiFS (56mts) and LISS-III (23.5 mts.), from 2020 onwards very high-resolution inventory using LISS IV with spatial resolution of 5.8 mts. are also being generated giving enhanced information of the catchment of any object up 5.8 mts. by virtue of which it has become possible to map all those lakes/water bodies of minute size (0.01 ha) as well up to clearly visible and can be digitized from pixel to pixel. Although the data procurement of the LISS-IV sensor is always a challenge due to its very fine resolution and the less swath in comparison to the LISS III and AWiFS sensors, however an attempt has been made in 2023 to procure whatever data which is cloud free and snow free was browsed, acquired and analysed. The data which was available mainly falls within 96/48a,96/48b, 96/48c, 96/48d, 97/48a, 97/48b, 97/48c, 97/49b, 98/49a, 98/48c, 98/49c, 99/49 a, 99/49 b, 99/49 c, 99/49 d,100-49c (Fig. 9.1-9.9) & (Table 9.1- 9.9).

9.1 INTERPRETED LAYER OF LISS-IV DATA IN SATLUJ BASIN IN 2023

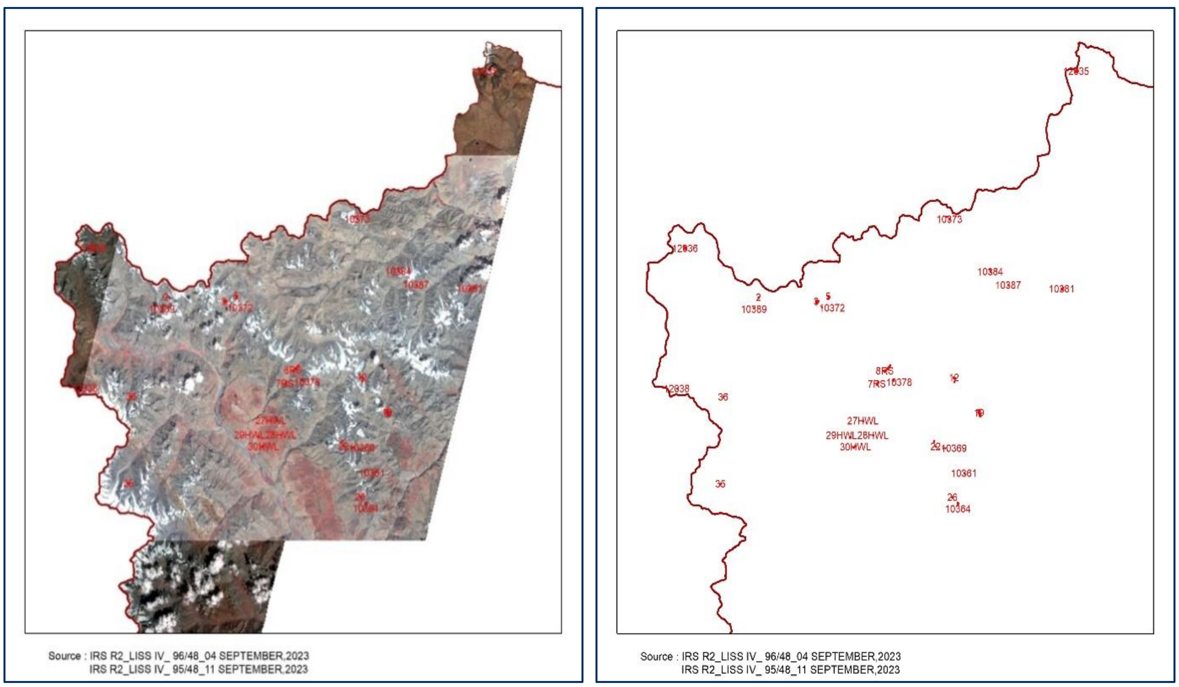


Fig. 9.1 (a) & (b): IRS R2, LISS IV, 96/48 a, 4th September and 95/48 b, 11th September, 2023 and its interpreted layer

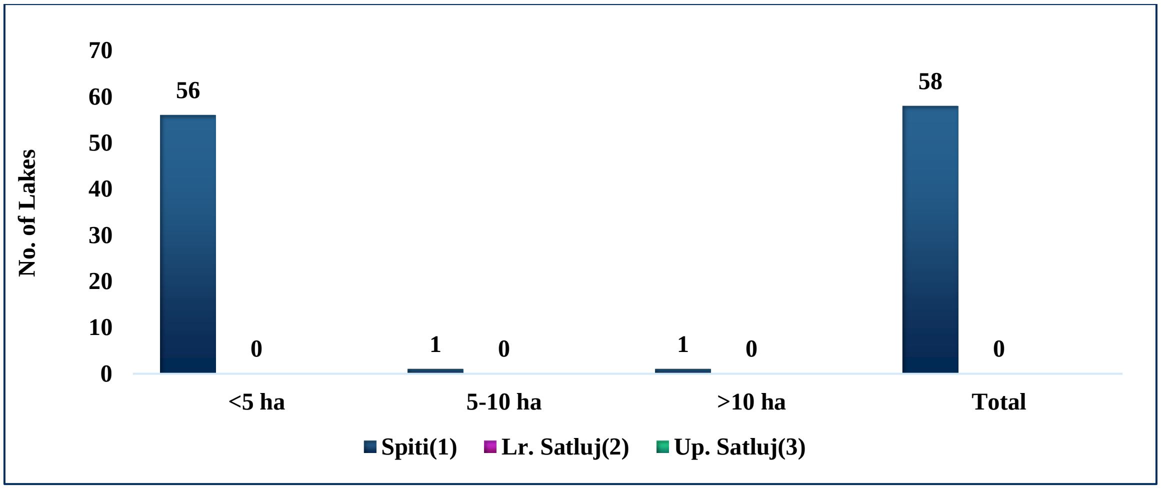


Fig. 9.1 (c): No. of lakes based on LISS-IV image 96/48a, 2023

Fig. 9.1 (d): No. of high-altitude wetland Lakes based on LISS-IV image 96/48a, 2023

Table: 9.1 Distribution of Lakes as per satellite data interpretation for 96/48a, 2023 using LISS-IV sensor

S. No.	Lake	Basin	Lat.	Long.	Area HA (2023)	S. No.	Lake	Basin	Lat.	Long.	Area HA (2023)
1	2	1	32.53	77.83	0.44	30	10378	1	32.41	78.10	0.11
2	3	1	32.53	77.94	2.44	31	10379	1	32.41	78.10	0.07
3	5	1	32.53	77.97	0.94	32	10380	1	32.41	78.10	0.03
4	6	1	32.53	77.97	0.18	33	10381	1	32.56	78.43	1.63
5	12	1	32.42	78.22	1.88	34	10382	1	32.55	78.43	0.17
6	13	1	32.41	78.22	0.15	35	10384	1	32.58	78.29	0.09
7	14	1	32.41	78.22	0.17	36	10385	1	32.58	78.29	0.02
8	18	1	32.37	78.27	0.34	37	10386	1	32.56	78.43	0.14

9	**19**	**1**	**32.36**	**78.27**	**13.60**	38	10387	1	32.56	78.32	0.37
10	22	1	32.31	78.19	0.84	39	10388	1	32.56	78.32	0.04
11	23	1	32.31	78.19	0.06	40	10389	1	32.51	77.82	0.22
12	26	1	32.23	78.22	0.55	41	10390	1	32.58	78.29	0.05
13	35	1	32.24	77.76	2.08	42	12035	1	32.89	78.45	7.94
14	36	1	32.38	77.76	0.22	43	12036	1	32.60	77.68	2.33
15	10361	1	32.27	78.24	0.38	44	12037	1	32.60	77.68	0.32
16	10362	1	32.22	78.23	0.05	45	12038	1	32.39	77.67	0.06
17	10363	1	32.22	78.23	0.04	46	7RS	1	32.40	78.07	1.33
18	10364	1	32.22	78.23	0.04	47	8RS	1	32.42	78.08	3.04
19	10365	1	32.22	78.23	0.05	48	9RS	1	32.43	78.09	1.95
20	10366	1	32.52	77.94	0.90	49	10RS	1	32.43	78.09	1.07
21	10367	1	32.32	78.18	0.12	50	11RS	1	32.43	78.09	0.39
22	10368	1	32.32	78.18	0.17	51	10377R	1	32.40	78.07	1.37
23	10369	1	32.31	78.20	0.27	52	27HWL	1	32.35	78.04	0.56
24	10370	1	32.31	78.21	0.02	53	28HWL	1	32.32	78.06	0.23
25	10371	1	32.53	77.95	0.04	54	29HWL	1	32.32	78.02	0.09
26	10372	1	32.52	77.95	0.16	55	30HWL	1	32.31	78.03	0.20
27	10373	1	32.66	78.20	0.31	56	31HWL	1	32.31	78.03	0.18
28	10374	1	32.66	78.20	0.23	57	32HWL	1	32.30	78.02	0.08
29	10376	1	32.66	78.20	0.04	58	33HWL	1	32.30	78.02	0.04

HWL= High Altitude Wetland

RS= River Section

SG= Supra Glacier lakes

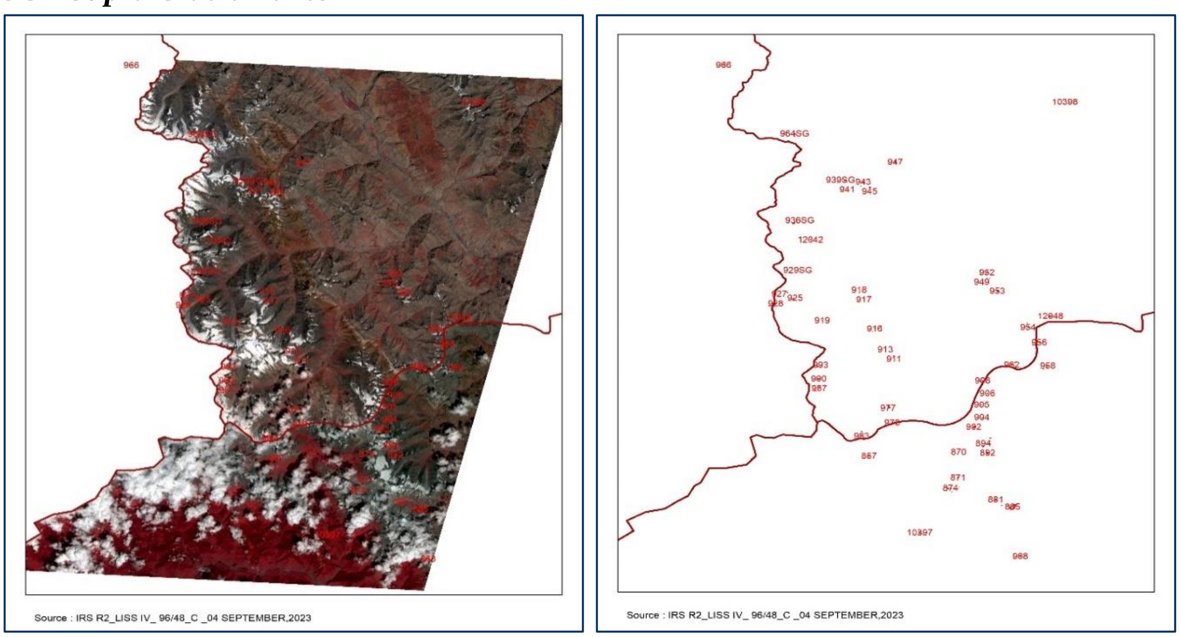


Fig. 9.2 (a) & (b): IRS R2, LISS IV, 96/48 a, 4 September and its interpreted layer

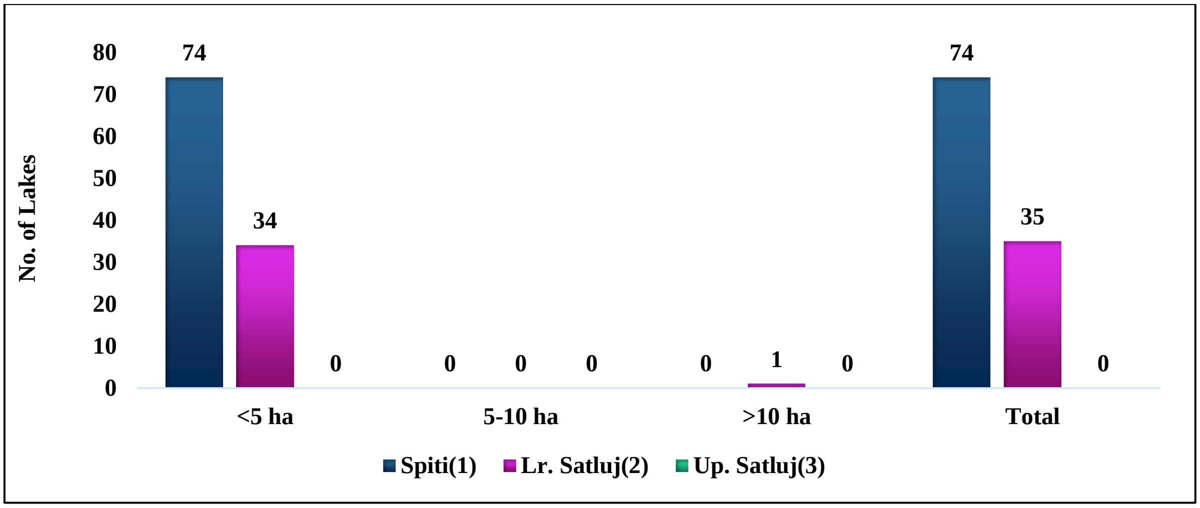


Fig. 9.2 (c): No of lakes based on LISS-IV image 96/48c, 2023

Table: 9.2 Distribution of Lakes as per satellite data interpretation for 96/48c, 2023 using LISS-IV sensor

S. No	Basin	Lake	Lat.	Long.	Area Ha (2023)	S. No	Basin	Lake	Lat.	Long.	Area Ha (2023)
1	2	867	31.73	77.94	0.55	56	1	952	32.01	78.11	0.44
2	2	870	31.74	78.08	0.09	57	1	953	31.98	78.13	1.84
3	2	871	31.70	78.08	0.81	58	1	954	31.93	78.18	0.21
4	2	872	31.69	78.08	0.02	59	1	955	31.93	78.18	0.09
5	2	873	31.68	78.07	0.12	60	2	956	31.91	78.20	0.32
6	2	874	31.69	78.07	0.18	61	2	957	31.87	78.21	0.04
7	2	875	31.69	78.06	0.03	62	2	958	31.87	78.22	0.35
8	2	876	31.69	78.06	0.07	63	2	959	31.87	78.21	0.14
9	2	877	31.69	78.06	0.09	64	2	960	31.87	78.21	0.04
10	2	878	31.69	78.06	0.11	65	1	961	31.87	78.16	0.01
11	2	880	31.67	78.14	0.04	66	1	962	31.87	78.16	0.13
12	2	881	31.67	78.14	0.43	67	1	966	32.30	77.69	0.13
13	2	882	31.66	78.15	0.12	68	2	968	31.59	78.18	0.14
14	2	883	31.66	78.16	0.38	69	2	976	31.78	77.97	0.12
15	**2**	**885**	**31.66**	**78.17**	**34.30**	70	1	977	31.80	77.96	0.29
16	2	886	31.66	78.16	0.51	71	1	978	31.80	77.97	0.02
17	2	891	31.74	78.13	0.26	72	1	979	31.80	77.97	0.06
18	2	892	31.74	78.12	3.43	73	1	980	31.80	77.97	0.28
19	2	894	31.75	78.12	0.34	74	1	981	31.80	77.96	0.05
20	2	895	31.75	78.13	0.18	75	1	982	31.81	77.96	0.23
21	2	897	31.76	78.13	0.15	76	1	983	31.76	77.92	0.56
22	2	898	31.76	78.13	0.04	77	1	984	31.77	77.92	0.12

23	2	899	31.76	78.13	0.04	78	1	985	31.83	77.85	0.09
24	2	902	31.78	78.10	2.29	79	1	986	31.83	77.86	0.03
25	2	903	31.78	78.10	1.19	80	1	987	31.83	77.86	0.10
26	2	904	31.79	78.11	0.35	81	1	988	31.84	77.85	0.01
27	2	905	31.81	78.11	0.20	82	1	989	31.84	77.85	0.04
28	1	906	31.83	78.12	0.11	83	1	990	31.84	77.85	0.42
29	1	907	31.85	78.11	0.05	84	1	991	31.86	77.85	0.04
30	1	908	31.85	78.11	0.07	85	1	992	31.86	77.85	0.07
31	1	911	31.88	77.97	0.03	86	1	993	31.86	77.86	0.41
32	1	912	31.88	77.97	0.02	87	2	10397	31.62	78.02	4.30
33	1	913	31.89	77.96	0.24	88	1	10398	32.26	78.23	0.05
34	1	915	31.91	77.94	0.06	89	1	12039	32.20	77.80	0.12
35	1	916	31.92	77.94	0.09	90	1	12040	32.07	77.81	0.09
36	1	917	31.96	77.92	0.05	91	1	12041	32.07	77.81	0.02
37	1	918	31.97	77.91	0.04	92	1	12042	32.05	77.83	0.04
38	1	919	31.93	77.86	0.07	93	1	12043	32.05	77.83	0.04
39	1	922	31.96	77.81	0.08	94	1	12044	32.05	77.83	0.03
40	1	923	31.96	77.81	0.06	95	1	12045	32.05	77.83	0.03
41	1	924	31.96	77.81	0.03	96	1	12046	32.05	77.84	0.03
42	1	925	31.96	77.81	0.19	97	1	12047	32.05	77.84	0.03
43	1	926	31.97	77.80	0.21	98	1	12048	31.94	78.22	1.92
44	1	927	31.96	77.79	0.23	99	1	929SG	32.00	77.82	0.03
45	1	928	31.95	77.78	0.63	100	1	932SG	32.05	77.84	0.01
46	1	941	32.12	77.89	0.04	101	1	934SG	32.07	77.81	0.05
47	1	943	32.14	77.91	1.17	102	1	936SG	32.08	77.82	0.13
48	1	944	32.14	77.92	0.04	103	1	937SG	32.08	77.83	0.05
49	1	945	32.13	77.93	1.07	104	1	939SG	32.14	77.88	0.07
50	1	946	32.17	77.96	0.18	105	1	940SG	32.14	77.89	0.06
51	1	947	32.17	77.96	0.68	106	1	942SG	32.13	77.91	0.06
52	1	948	32.17	77.96	0.05	107	1	964SG	32.21	77.80	0.15
53	1	949	32.00	78.12	0.16	108	1	965SG	32.20	77.80	0.06
54	1	950	32.00	78.12	0.03	109	1	965SG	32.20	77.80	0.03
55	1	951	32.01	78.11	0.04						

HWL= High Altitude Wetland
RS= River Section
SG= Supra Glacier lakes

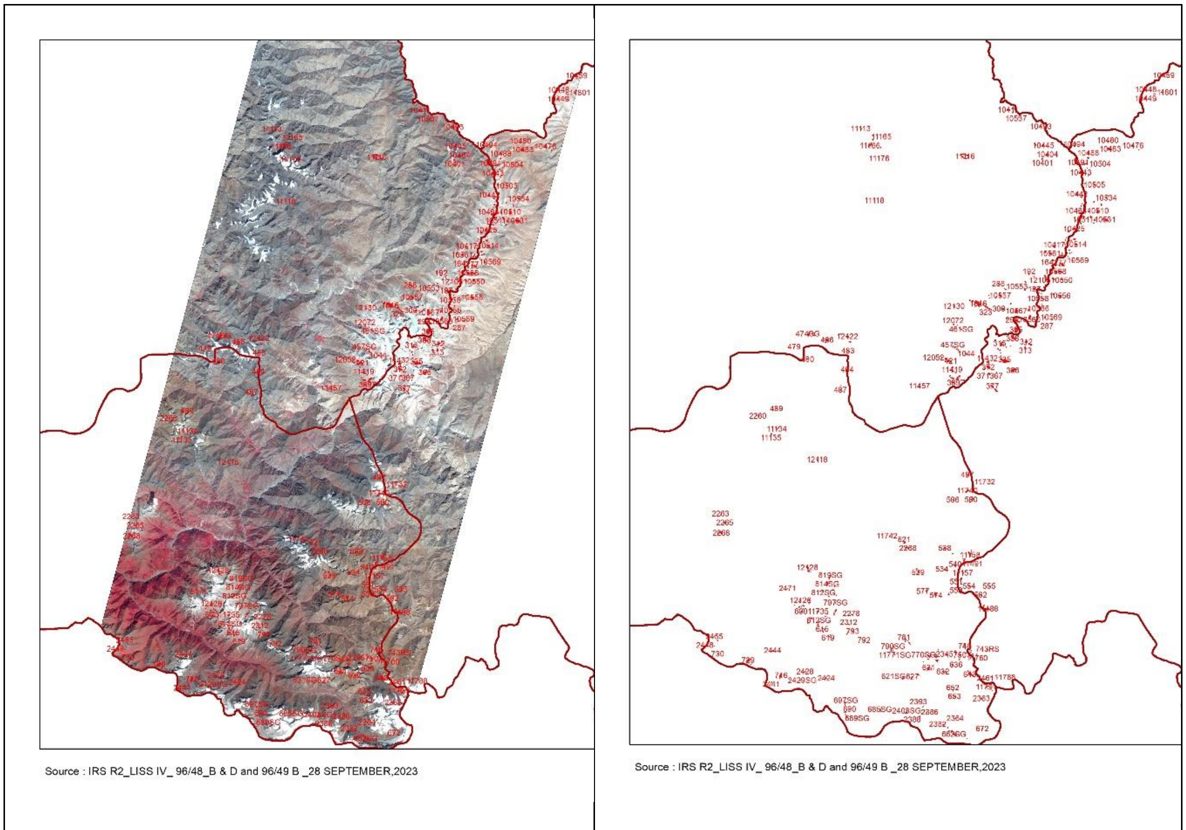
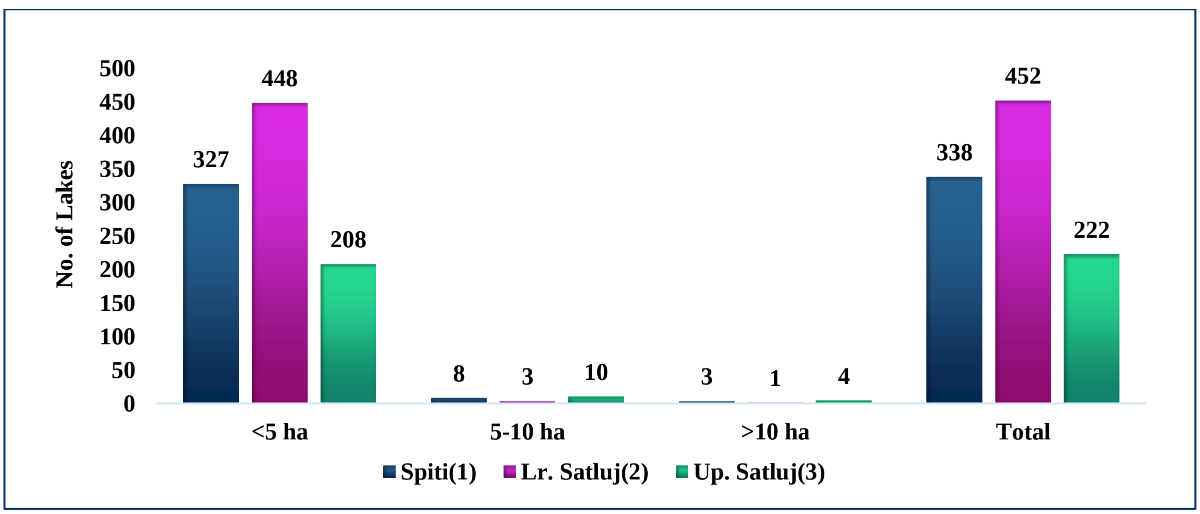


Fig. 9.3 (a) & (b): IRS R2, LISS IV, 96/48 b and d, 28 September and its interpreted layer



9.3 (c): No. of lakes based on LISS-IV image 96/48 b & d, 2023

Table: 9.3 Distribution of Lakes as per satellite data interpretation for 96/48b & d, 2023 using LISS-IV sensor

S. No.	Basin	Lake	Lat.	Long	Area Ha (2023)	S. No.	Basin	Lake	Lat.	Long	Area Ha (2023)
1	110	1	32.04	78.76	0.04	**507**	10494	3	32.35	78.97	0.45
2	158	1	32.14	78.95	0.06	**508**	10495	3	32.35	78.97	0.10
3	159	1	32.14	78.95	0.02	**509**	10497	3	32.32	78.99	0.56
4	162	1	32.13	78.93	0.91	**510**	10498	3	32.32	78.99	1.47
5	163	1	32.13	78.93	0.11	**511**	10499	3	32.32	79.00	0.21
6	164	1	32.13	78.92	0.15	**512**	10500	3	32.32	79.00	0.14
7	176	1	32.10	78.91	0.11	**513**	10501	3	32.30	79.00	0.30
8	177	1	32.10	78.91	0.77	**514**	10502	3	32.29	79.00	0.28
9	180	1	32.08	78.91	0.19	**515**	10503	3	32.31	79.00	0.15
10	183	3	32.06	78.90	0.06	**516**	10504	3	32.31	79.01	0.02
11	184	3	32.07	78.89	0.15	**517**	10505	3	32.28	79.02	2.17
12	185	3	32.06	78.89	0.18	**518**	10506	3	32.28	78.99	0.55
13	187	1	32.07	78.88	2.42	**519**	10507	3	32.24	79.02	0.30
14	188	1	32.07	78.88	0.44	**520**	10508	3	32.24	79.03	0.13
15	191	1	32.10	78.88	0.22	**521**	10509	3	32.24	79.03	1.05
16	192	1	32.10	78.87	0.17	**522**	10510	3	32.22	79.03	6.36
17	215	1	31.97	78.41	0.51	**523**	10511	3	32.21	79.01	1.96
18	277	3	32.12	78.94	2.90	**524**	10512	3	32.21	79.02	2.80
19	279	3	32.12	78.94	0.46	**525**	10513	3	32.20	79.02	0.36
20	286	3	32.01	78.93	1.47	**526**	10514	3	32.16	78.98	8.48
21	287	3	32.00	78.90	0.76	**527**	10515	3	32.17	78.97	0.16
22	288	1	32.08	78.80	0.57	**528**	10516	3	32.17	78.97	0.10
23	289	1	32.08	78.81	0.45	**529**	10517	3	32.17	78.98	0.09
24	291	1	32.06	78.83	0.07	**530**	10518	3	32.17	78.97	0.10
25	292	1	32.04	78.83	0.81	**531**	10519	3	32.17	78.97	0.04
26	294	1	32.01	78.85	1.64	**532**	10520	3	32.17	78.97	1.60
27	295	1	32.01	78.85	0.13	**533**	10521	3	32.20	78.99	0.91
28	296	1	32.01	78.85	0.06	**534**	10522	3	32.20	78.99	0.07
29	297	1	32.01	78.85	1.06	**535**	10523	3	32.21	79.00	0.12
30	298	1	32.01	78.85	0.06	**536**	10524	3	32.21	78.99	0.03
31	299	1	32.01	78.85	0.31	**537**	10525	3	32.21	78.99	0.13
32	300	1	32.03	78.82	2.60	**538**	10526	3	32.22	78.99	0.03
33	301	1	32.03	78.81	0.28	**539**	10527	3	32.22	78.99	0.08
34	302	1	32.03	78.81	0.09	**540**	10528	3	32.22	78.99	0.08
35	303	1	32.03	78.81	0.19	**541**	10529	3	32.22	79.00	0.68
36	**305**	**3**	**31.99**	**78.84**	**21.07**	**542**	10530	3	32.22	79.01	2.51
37	306	3	31.99	78.85	1.68	**543**	**10531**	**3**	**32.21**	**79.04**	**24.02**

38	307	3	31.99	78.84	0.38	**544**	10532	3	32.21	79.05	0.17
39	308	3	31.98	78.84	4.59	**545**	10533	3	32.21	79.05	0.06
40	309	3	31.98	78.84	0.88	**546**	10534	3	32.25	79.04	1.10
41	310	3	31.98	78.84	1.68	**547**	10535	3	32.26	79.05	0.23
42	311	3	31.98	78.84	1.54	**548**	10536	3	32.35	78.97	0.07
43	312	3	31.97	78.87	7.73	**549**	10537	3	32.41	78.83	0.19
44	313	3	31.96	78.87	4.05	**550**	10548	3	32.09	78.93	0.24
45	314	3	31.97	78.80	0.53	**551**	10549	3	32.09	78.93	0.05
46	314	3	31.97	78.80	0.53	**552**	10550	3	32.09	78.95	3.53
47	315	3	31.96	78.81	4.06	**553**	10551	3	32.09	78.93	0.87
48	316	3	31.96	78.81	0.07	**554**	10552	1	32.09	78.86	1.15
49	319	3	31.95	78.81	0.52	**555**	10553	1	32.07	78.86	1.34
50	321	3	31.95	78.81	0.08	**556**	10554	1	32.07	78.82	0.38
51	323	1	32.03	78.78	0.21	**557**	10555	3	32.06	78.93	1.30
52	324	1	32.03	78.78	0.05	**558**	10556	3	32.06	78.94	6.83
53	325	1	32.03	78.78	0.04	**559**	10557	1	32.06	78.81	6.97
54	326	1	32.03	78.78	0.86	**560**	10558	3	32.05	78.90	0.80
55	327	1	32.03	78.78	0.35	**561**	10559	3	32.04	78.90	0.52
56	328	1	32.04	78.75	0.18	**562**	10560	1	32.04	78.76	0.04
57	329	1	32.04	78.75	0.72	**563**	10560	1	32.02	78.87	8.13
58	335	3	31.93	78.82	2.16	**564**	10561	1	32.14	78.92	3.66
59	335	3	31.93	78.81	2.36	**565**	10561	1	32.04	78.76	0.12
60	336	3	31.93	78.81	0.15	**566**	10562	1	32.04	78.76	0.05
61	338	3	31.93	78.82	1.85	**567**	10562	3	32.14	78.96	0.61
62	339	3	31.93	78.82	0.16	**568**	10563	1	32.04	78.76	0.05
63	340	3	31.93	78.82	0.99	**569**	10563	3	32.15	78.96	1.77
64	341	3	31.93	78.83	0.17	**570**	10564	1	32.14	78.92	0.21
65	342	3	31.93	78.82	0.09	**571**	10565	1	32.04	78.76	0.03
66	344	3	31.93	78.83	0.21	**572**	10565	3	32.11	78.94	9.88
67	345	3	31.93	78.83	0.15	**573**	10566	1	32.03	78.87	4.03
68	346	3	31.93	78.83	0.36	**574**	10566	3	32.12	78.95	1.46
69	347	3	31.93	78.82	0.14	**575**	**10567**	**1**	**32.03**	**78.84**	**16.62**
70	348	3	31.93	78.82	0.10	**576**	10567	3	32.11	78.95	0.54
71	349	3	31.93	78.82	0.26	**577**	10568	1	32.02	78.88	2.01
72	350	3	31.93	78.82	0.09	**578**	**10568**	**3**	**32.11**	**78.93**	**10.35**
73	351	3	31.93	78.82	0.79	**579**	10569	3	32.02	78.91	5.09
74	352	3	31.93	78.82	0.03	**580**	10569	3	32.13	78.97	3.14
75	353	3	31.93	78.82	0.07	**581**	10570	3	32.12	78.95	1.37
76	354	3	31.93	78.82	0.03	**582**	10571	3	32.14	78.96	0.27
77	355	3	31.93	78.82	0.23	**583**	10572	1	32.07	78.82	0.02
78	356	3	31.93	78.82	0.06	**584**	10574	1	32.07	78.82	0.31
79	357	3	31.93	78.82	1.32	**585**	10575	1	32.04	78.77	0.09

80	358	3	31.93	78.82	0.10	**586**	10576	1	32.04	78.77	0.28
81	359	3	31.93	78.82	0.02	**587**	10579	1	32.04	78.77	0.12
82	360	3	31.93	78.82	0.05	**588**	10580	1	32.04	78.77	0.02
83	361	3	31.93	78.82	0.04	**589**	11084	1	31.98	78.37	0.19
84	366	3	31.91	78.84	6.09	**590**	11093	1	32.71	78.71	2.93
85	367	3	31.91	78.80	0.63	**591**	11094	1	32.71	78.71	0.13
86	369	3	31.91	78.79	0.37	**592**	11095	1	32.71	78.71	0.02
87	370	3	31.91	78.79	0.16	**593**	11096	1	32.71	78.71	0.05
88	371	3	31.91	78.78	0.25	**594**	11097	1	32.71	78.69	5.00
89	**372**	**3**	**31.92**	**78.78**	**18.31**	**595**	11098	1	32.71	78.71	0.54
90	374	3	31.88	78.79	0.48	**596**	11099	1	32.71	78.70	0.34
91	377	3	31.88	78.79	0.69	**597**	11100	1	32.71	78.70	0.32
92	378	3	31.88	78.79	0.32	**598**	11101	1	32.71	78.71	0.63
93	379	3	31.88	78.79	0.10	**599**	11102	1	32.71	78.70	0.04
94	381	3	31.88	78.80	0.10	**600**	11103	1	32.71	78.68	0.87
95	383	3	31.88	78.80	0.44	**601**	11104	1	32.71	78.70	0.12
96	384	3	31.87	78.80	0.07	**602**	11105	1	32.71	78.70	0.37
97	385	3	31.87	78.80	0.10	**603**	11106	1	32.70	78.70	3.79
98	386	3	31.87	78.80	0.65	**604**	11107	1	32.71	78.70	0.88
99	387	3	31.87	78.80	0.16	**605**	11108	1	32.70	78.74	0.23
100	388	3	31.87	78.80	0.08	**606**	11109	1	32.70	78.72	0.83
101	389	1	31.89	78.70	1.47	**607**	11110	1	32.70	78.73	1.93
102	391	1	31.89	78.70	0.08	**608**	11111	1	32.69	78.71	2.70
103	392	1	31.89	78.70	0.25	**609**	11112	1	32.70	78.73	0.25
104	414	1	31.90	78.72	1.04	**610**	11113	1	32.38	78.48	1.07
105	415	1	31.90	78.72	0.52	**611**	11115	1	32.34	78.53	0.13
106	416	1	31.90	78.71	0.68	**612**	**11116LS**	**1**	**32.33**	**78.72**	**111.36**
107	421	1	31.93	78.70	0.66	**613**	11118	1	32.24	78.52	0.32
108	422	1	31.93	78.70	0.01	**614**	11133	2	31.79	78.30	0.07
109	423	1	31.93	78.70	0.27	**615**	11134	2	31.79	78.31	1.61
110	424	1	31.93	78.69	0.20	**616**	11135	2	31.78	78.29	1.30
111	425	1	31.93	78.69	0.34	**617**	11136	1	32.71	78.71	0.05
112	426	1	31.93	78.69	0.25	**618**	11137	1	32.71	78.69	0.32
113	427	1	31.93	78.69	0.08	**619**	11138	1	32.73	78.69	0.76
114	428	1	31.93	78.69	0.16	**620**	11139	1	32.73	78.70	0.09
115	429	1	31.93	78.69	0.16	**621**	11145	3	31.91	78.77	0.35
116	430	1	31.93	78.69	0.11	**622**	11157	2	31.52	78.73	3.32
117	431	1	31.93	78.69	0.42	**623**	11158	2	31.55	78.75	4.61
118	433	1	31.93	78.69	0.05	**624**	11159	1	32.35	78.51	0.07
119	434	1	31.93	78.69	0.09	**625**	11160	1	32.35	78.50	0.04
120	463	1	32.00	78.71	0.30	**626**	11161	1	32.36	78.51	0.15
121	466	1	31.96	78.42	6.50	**627**	11162	1	32.35	78.50	0.06

122	479	1	31.95	78.34	0.28	**628**	11163	1	32.36	78.51	0.04
123	480	2	31.93	78.37	0.26	**629**	11164	1	32.35	78.51	0.06
124	481	1	31.96	78.47	0.10	**630**	11165	1	32.36	78.51	0.42
125	482	1	31.96	78.47	0.09	**631**	11166	1	32.34	78.50	0.50
126	483	1	31.94	78.46	1.05	**632**	11167	1	32.35	78.50	0.33
127	484	2	31.91	78.46	0.08	**633**	11168	1	32.34	78.50	0.06
128	486	2	31.87	78.45	0.03	**634**	11169	1	32.34	78.50	0.05
129	487	2	31.87	78.45	0.18	**635**	11171	1	32.35	78.50	0.10
130	488	2	31.87	78.45	0.08	**636**	11172	1	32.35	78.50	0.13
131	489	2	31.83	78.30	0.07	**637**	11176	1	32.32	78.52	0.08
132	497	2	31.71	78.74	2.17	**638**	11419	1	31.91	78.70	2.37
133	500	2	31.66	78.75	0.58	**639**	11420	1	31.91	78.71	0.29
134	502	2	31.66	78.75	0.12	**640**	11421	1	31.92	78.70	0.38
135	503	2	31.66	78.75	0.32	**641**	11422	1	31.95	78.71	0.02
136	504	2	31.66	78.76	0.08	**642**	11423	1	31.95	78.71	0.10
137	506	2	31.66	78.71	0.14	**643**	11424	1	32.05	78.78	0.06
138	519	2	31.57	78.60	0.38	**644**	11425	1	32.06	78.78	0.06
139	520	2	31.57	78.60	0.04	**645**	11426	1	32.06	78.78	0.08
140	521	2	31.58	78.60	0.52	**646**	11427	1	32.06	78.80	0.11
141	522	2	31.57	78.60	0.42	**647**	11428	1	32.06	78.80	0.18
142	523	2	31.58	78.60	0.19	**648**	11429	1	32.06	78.80	0.06
143	524	2	31.57	78.60	0.34	**649**	11430	1	32.14	78.95	0.59
144	526	2	31.52	78.63	0.04	**650**	11432	3	31.93	78.78	6.02
145	527	2	31.52	78.63	0.19	**651**	11433	3	31.93	78.78	0.35
146	528	2	31.52	78.63	0.02	**652**	11434	3	31.93	78.78	1.13
147	529	2	31.52	78.63	0.47	**653**	11436	3	31.88	78.80	0.03
148	531	2	31.52	78.64	0.02	**654**	11437	3	31.92	78.84	0.10
149	532	2	31.52	78.63	0.02	**655**	11438	3	31.95	78.80	0.16
150	534	2	31.52	78.69	0.09	**656**	11440	3	31.96	78.82	0.06
151	535	2	31.53	78.69	0.06	**657**	11441	3	31.98	78.84	0.08
152	536	2	31.53	78.69	0.04	**658**	11442	3	31.98	78.84	0.20
153	537	2	31.57	78.69	0.04	**659**	11443	3	31.98	78.84	0.08
154	538	2	31.57	78.69	0.28	**660**	11444	3	31.97	78.84	1.78
155	539	2	31.56	78.71	0.26	**661**	11445	3	31.98	78.84	0.07
156	540	2	31.53	78.72	0.91	**662**	11446	3	31.98	78.84	0.04
157	541	2	31.52	78.71	0.09	**663**	11447	3	31.98	78.85	0.55
158	542	2	31.56	78.75	0.51	**664**	11455	1	32.14	78.91	1.43
159	551	2	31.51	78.73	0.93	**665**	11456	1	32.01	78.82	1.16
160	552	2	31.50	78.73	0.04	**666**	11457	1	31.88	78.63	0.87
161	553	2	31.49	78.73	0.51	**667**	11458	1	31.88	78.63	0.15
162	554	2	31.49	78.75	1.47	**668**	11459	1	31.98	78.39	0.07
163	555	3	31.49	78.80	0.16	**669**	11460	1	31.97	78.39	0.14

164	559	2	31.46	78.78	0.58	**670**	11488	1	31.45	78.79	8.01
165	560	2	31.45	78.78	0.15	**671**	11488	1	31.45	78.79	8.01
166	561	2	31.45	78.78	0.02	**672**	11491	2	31.54	78.74	1.36
167	562	2	31.48	78.78	0.21	**673**	11491	2	31.54	78.74	1.36
168	564	2	31.48	78.70	0.10	**674**	11492	2	31.54	78.74	0.39
169	565	2	31.48	78.70	0.05	**675**	11492	2	31.54	78.74	0.39
170	566	2	31.48	78.70	0.04	**676**	11493	2	31.55	78.74	0.24
171	567	2	31.48	78.67	0.05	**677**	11493	2	31.55	78.74	0.24
172	568	2	31.48	78.67	0.14	**678**	11494	2	31.56	78.75	0.06
173	569	2	31.47	78.67	0.14	**679**	11495	2	31.56	78.75	0.03
174	570	2	31.48	78.67	0.03	**680**	11496	2	31.56	78.77	0.13
175	572	2	31.47	78.67	0.04	**681**	11496	2	31.56	78.77	0.13
176	574	2	31.47	78.68	0.53	**682**	11497	2	31.56	78.75	0.49
177	575	2	31.48	78.65	0.02	**683**	11731	1	31.69	78.77	0.07
178	576	2	31.48	78.65	0.34	**684**	11732	1	31.69	78.77	0.10
179	577	2	31.48	78.65	0.38	**685**	11733	2	31.56	78.75	0.03
180	580	2	31.52	78.39	0.12	**686**	11734	2	31.55	78.75	0.10
181	582	2	31.51	78.39	0.07	**687**	11734	2	31.56	78.75	0.04
182	598	2	31.44	78.37	0.14	**688**	11735	2	31.44	78.41	1.61
183	599	2	31.44	78.37	0.06	**689**	11736	1	31.97	78.39	0.05
184	600	2	31.44	78.37	0.26	**690**	11737	1	31.98	78.39	0.05
185	601	2	31.41	78.39	0.30	**691**	11738	1	31.97	78.37	0.08
186	603	2	31.42	78.39	0.12	**692**	11739	1	31.97	78.37	0.14
187	604	2	31.42	78.39	0.03	**693**	11740	2	31.68	78.74	5.20
188	605	2	31.42	78.39	0.17	**694**	11742	2	31.59	78.57	0.14
189	606	2	31.42	78.39	0.08	**695**	11743	2	31.56	78.69	0.04
190	607	2	31.44	78.41	0.23	**696**	11747	2	31.42	78.39	0.04
191	613	2	31.40	78.42	0.63	**697**	11748	2	31.41	78.39	0.05
192	615	2	31.40	78.42	2.44	**698**	11752	2	31.38	78.74	0.07
193	616	2	31.40	78.42	1.05	**699**	11754	2	31.39	78.61	0.04
194	617	2	31.40	78.42	0.27	**700**	11755	2	31.39	78.61	0.02
195	618	2	31.40	78.42	0.24	**701**	11756	2	31.39	78.61	0.08
196	619	2	31.39	78.43	0.47	**702**	11757	2	31.39	78.61	0.06
197	625	2	31.31	78.62	0.21	**703**	11759	2	31.37	78.76	0.06
198	626	2	31.31	78.63	0.05	**704**	11760	2	31.35	78.76	1.73
199	627	2	31.31	78.63	0.24	**705**	11761	2	31.36	78.75	0.16
200	629	2	31.33	78.66	0.08	**706**	11762	2	31.36	78.74	0.08
201	631	2	31.33	78.66	0.95	**707**	11763	2	31.35	78.73	0.35
202	632	2	31.33	78.69	1.73	**708**	11764	2	31.35	78.73	0.02
203	633	2	31.33	78.70	1.64	**709**	11765	2	31.34	78.72	0.05
204	636	2	31.34	78.72	1.12	**710**	11767	2	31.36	78.31	0.03
205	641	2	31.32	78.75	0.63	**711**	11768	2	31.36	78.31	0.04

206	642	2	31.32	78.75	0.05	**712**	11779	2	31.33	78.26	0.04
207	643	2	31.32	78.76	0.97	**713**	11780	2	31.33	78.26	0.08
208	650	2	31.30	78.80	0.24	**714**	11786	2	31.32	78.75	0.06
209	651	2	31.29	78.80	0.52	**715**	11787	2	31.32	78.75	0.04
210	652	2	31.29	78.72	0.05	**716**	11788	1	31.32	78.82	0.23
211	653	2	31.28	78.72	0.07	**717**	11789	2	31.32	78.64	0.09
212	654	2	31.24	78.72	0.06	**718**	11791	2	31.30	78.79	1.25
213	672	2	31.22	78.79	0.23	**719**	11792	2	31.30	78.80	0.05
214	673	2	31.22	78.79	0.04	**720**	11793	2	31.30	78.80	0.12
215	690	2	31.25	78.49	0.27	**721**	11794	2	31.29	78.81	0.06
216	699	2	31.31	78.33	0.30	**722**	11795	2	31.29	78.81	0.09
217	700	2	31.31	78.33	0.07	**723**	11797	2	31.22	78.70	0.07
218	701	2	31.31	78.33	0.14	**724**	11798	2	31.21	78.72	0.05
219	702	2	31.31	78.33	0.02	**725**	11799	2	31.21	78.72	0.03
220	704	2	31.31	78.33	0.09	**726**	11800	2	31.20	78.73	0.06
221	705	2	31.31	78.33	0.03	**727**	11801	3	32.46	79.17	0.86
222	707	2	31.31	78.33	0.04	**728**	12049	3	31.96	78.88	0.28
223	708	2	31.31	78.33	0.07	**729**	12050	3	31.91	78.79	0.50
224	709	2	31.31	78.33	0.36	**730**	12051	1	31.93	78.68	0.76
225	710	2	31.31	78.33	0.26	**731**	12052	1	31.94	78.68	0.25
226	711	2	31.31	78.33	0.14	**732**	12053	1	31.94	78.67	0.07
227	712	2	31.31	78.33	0.13	**733**	12054	1	31.94	78.68	0.07
228	713	2	31.31	78.33	0.15	**734**	12055	1	31.93	78.69	0.04
229	714	2	31.31	78.33	0.16	**735**	12056	1	31.90	78.72	0.03
230	715	2	31.31	78.33	0.24	**736**	12057	1	31.89	78.71	0.08
231	716	2	31.31	78.33	0.98	**737**	12058	1	31.89	78.71	0.04
232	717	2	31.31	78.33	0.15	**738**	12059	1	31.89	78.71	0.07
233	718	2	31.31	78.33	0.14	**739**	12060	1	31.89	78.73	0.04
234	719	2	31.31	78.33	0.21	**740**	12061	1	31.89	78.73	0.07
235	720	2	31.31	78.33	0.06	**741**	12062	1	31.89	78.73	0.03
236	721	2	31.31	78.33	0.07	**742**	12063	1	31.89	78.72	0.02
237	722	2	31.31	78.33	0.07	**743**	12064	1	31.90	78.70	0.03
238	723	2	31.31	78.33	0.05	**744**	12065	1	31.91	78.71	0.08
239	724	2	31.31	78.33	0.51	**745**	12066	1	31.91	78.70	0.12
240	725	2	31.31	78.33	0.56	**746**	12067	1	31.91	78.70	0.06
241	728	2	31.33	78.26	0.66	**747**	12068	1	31.99	78.72	0.04
242	**729**	**2**	**31.34**	**78.25**	**14.54**	**748**	12069	1	31.99	78.72	0.11
243	730	2	31.35	78.18	0.52	**749**	12070	1	32.00	78.70	0.14
244	744	2	31.36	78.77	0.49	**750**	12071	1	32.00	78.70	0.13
245	745	2	31.36	78.76	0.58	**751**	12072	1	32.00	78.70	0.06
246	746	2	31.37	78.74	0.77	**752**	12073	1	32.06	78.80	0.14
247	747	2	31.38	78.74	0.23	**753**	12074	3	31.95	78.80	0.43

248	748	2	31.36	78.73	0.17	**754**	12075	3	31.95	78.81	0.03
249	749	2	31.36	78.73	0.06	**755**	12076	3	31.96	78.82	0.05
250	750	2	31.36	78.73	1.78	**756**	12077	3	31.96	78.83	0.13
251	751	2	31.36	78.72	1.00	**757**	12078	3	31.96	78.82	0.11
252	752	2	31.37	78.72	0.36	**758**	12079	3	31.96	78.82	0.09
253	768	2	31.37	78.68	0.11	**759**	12080	3	31.95	78.81	0.06
254	781	2	31.39	78.60	0.07	**760**	12081	3	31.95	78.81	0.09
255	792	2	31.38	78.52	0.33	**761**	12082	3	31.45	78.80	0.11
256	793	2	31.40	78.49	2.22	**762**	12083	3	31.69	78.77	0.07
257	794	2	31.39	78.48	0.08	**763**	12084	3	31.69	78.77	0.10
258	806	2	31.43	78.43	0.17	**764**	12085	2	31.56	78.75	0.03
259	807	2	31.43	78.43	0.04	**765**	12086	2	31.55	78.75	0.10
260	827	1	32.03	78.79	0.14	**766**	12087	2	31.56	78.75	0.04
261	828	1	32.03	78.78	0.10	**767**	12088	3	32.12	78.94	0.20
262	829	1	32.04	78.78	0.09	**768**	12089	1	32.04	78.75	0.11
263	830	1	32.04	78.78	0.08	**769**	12090	1	32.04	78.76	0.04
264	994	1	32.04	78.77	0.10	**770**	12091	1	32.04	78.76	0.04
265	995	1	32.04	78.77	0.14	**771**	12092	3	31.93	78.83	0.05
266	996	1	32.04	78.77	0.42	**772**	12093	3	31.88	78.79	0.20
267	997	1	32.04	78.77	0.03	**773**	12094	3	31.88	78.79	0.09
268	998	1	32.04	78.77	0.07	**774**	12095	1	32.04	78.75	0.05
269	999	1	32.04	78.77	0.08	**775**	12096	3	31.93	78.83	0.05
270	1000	1	32.04	78.76	0.06	**776**	12097	3	31.93	78.83	0.03
271	1001	1	32.04	78.76	0.65	**777**	12098	1	32.04	78.74	0.03
272	1003	1	32.04	78.76	0.11	**778**	12099	3	31.93	78.82	0.04
273	1004	1	32.04	78.76	0.13	**779**	12100	1	31.90	78.70	0.14
274	1007	1	32.04	78.76	0.28	**780**	12101	3	31.88	78.80	0.06
275	1008	1	32.04	78.76	0.27	**781**	12102	3	31.88	78.80	0.11
276	1009	1	32.04	78.76	0.11	**782**	12103	3	31.88	78.79	0.04
277	1011	1	32.04	78.76	0.10	**783**	12104	3	32.06	78.90	0.08
278	1012	1	32.04	78.76	0.42	**784**	12105	1	32.09	78.91	2.28
279	1013	1	32.04	78.76	0.09	**785**	12106	3	32.12	78.95	1.20
280	1014	1	32.04	78.76	0.23	**786**	12107	3	32.14	78.97	0.15
281	1015	1	32.04	78.76	0.06	**787**	12108	3	32.12	78.93	0.15
282	1016	1	32.04	78.76	1.86	**788**	12109	3	32.12	78.93	0.29
283	1017	1	32.04	78.76	0.02	**789**	12110	3	32.12	78.93	0.03
284	1018	1	32.04	78.76	0.06	**790**	12111	1	32.13	78.92	0.04
285	1019	1	32.04	78.76	0.05	**791**	12112	1	32.13	78.92	0.02
286	1020	1	32.04	78.76	0.02	**792**	12113	1	32.75	78.72	2.30
287	1021	1	32.04	78.76	0.21	**793**	12114	1	32.70	78.74	0.11
288	1022	1	32.04	78.76	0.62	**794**	12115	1	32.70	78.74	0.04
289	1023	1	32.05	78.75	0.10	**795**	12116	1	32.34	78.50	0.20

290	1024	1	32.05	78.75	0.03	**796**	12117	1	32.34	78.50	0.05
291	1025	1	32.05	78.75	0.10	**797**	12118	2	31.73	78.40	2.20
292	1026	1	32.05	78.75	0.09	**798**	12119	2	31.73	78.40	0.76
293	1027	1	32.04	78.75	0.27	**799**	12120	2	31.79	78.31	0.15
294	1028	1	32.04	78.75	0.26	**800**	12121	2	31.79	78.30	0.07
295	1029	1	32.04	78.75	0.83	**801**	12122	1	31.97	78.46	8.74
296	1030	1	32.04	78.75	0.08	**802**	12123	1	31.97	78.47	0.24
297	1031	1	32.05	78.74	0.84	**803**	12124	1	31.98	78.44	0.23
298	1032	1	32.05	78.75	0.33	**804**	12125	1	31.98	78.44	0.04
299	1033	1	32.04	78.74	0.35	**805**	12126	2	31.46	78.37	1.31
300	1034	1	32.05	78.74	0.05	**806**	12127	2	31.46	78.37	0.34
301	1035	1	32.04	78.75	0.02	**807**	12128	2	31.52	78.38	5.97
302	1037	1	32.04	78.75	0.04	**808**	12129	2	31.52	78.39	3.09
303	1038	1	32.05	78.74	0.12	**809**	12130	3	32.04	78.70	1.33
304	1039	1	32.05	78.74	0.02	**810**	12130	2	31.33	78.66	0.99
305	1040	1	32.03	78.70	0.10	**811**	12131	3	32.40	78.89	0.50
306	1041	1	32.03	78.70	0.06	**812**	12132	3	32.75	78.70	1.04
307	1043	1	32.04	78.70	0.10	**813**	12133	3	32.75	78.70	0.42
308	1044	1	31.94	78.73	0.34	**814**	12134	3	32.75	78.70	0.38
309	1045	1	31.94	78.73	0.07	**815**	12135	3	32.76	78.70	0.19
310	2032	3	32.14	78.95	0.03	**816**	12136	3	32.75	78.52	7.02
311	2033	1	32.14	78.95	0.18	**817**	11741SG	2	31.66	78.75	0.07
312	2034	1	32.14	78.95	0.06	**818**	11744SG	2	31.50	78.43	0.16
313	2037	1	32.14	78.94	0.05	**819**	11745SG	2	31.43	78.45	0.10
314	2038	1	32.14	78.94	0.04	**820**	11746SG	2	31.43	78.45	0.04
315	2039	1	32.14	78.94	0.13	**821**	11749SG	2	31.41	78.41	0.04
316	2042	1	32.10	78.91	0.04	**822**	11750SG	2	31.41	78.41	0.03
317	2043	1	32.10	78.91	0.02	**823**	11751SG	2	31.38	78.62	0.05
318	2044	1	32.10	78.91	0.05	**824**	11753SG	2	31.38	78.62	0.03
319	2101	3	32.10	78.92	0.75	**825**	11758SG	2	31.38	78.61	0.03
320	2142	1	32.07	78.89	0.06	**826**	11766SG	2	31.36	78.58	0.05
321	2151	1	31.96	78.41	0.09	**827**	11769SG	2	31.36	78.67	0.18
322	2152	1	31.96	78.47	0.02	**828**	11770SG	2	31.36	78.58	0.04
323	2153	1	32.03	78.81	0.03	**829**	11771SG	2	31.36	78.58	0.13
324	2154	1	32.03	78.81	0.03	**830**	11772SG	2	31.35	78.68	0.04
325	2155	1	32.03	78.81	0.06	**831**	11773SG	2	31.35	78.68	0.04
326	2201	1	31.93	78.69	0.04	**832**	11774SG	2	31.36	78.68	0.06
327	2202	1	31.93	78.69	0.04	**833**	11775SG	2	31.35	78.68	0.06
328	2204	1	31.93	78.69	0.01	**834**	11776SG	2	31.35	78.68	0.06
329	2205	1	31.93	78.69	0.01	**835**	11777SG	2	31.35	78.68	0.20
330	2239	3	31.94	78.81	0.28	**836**	11778SG	2	31.35	78.68	0.07
331	2241	3	31.92	78.84	0.32	**837**	11781SG	2	31.32	78.76	0.02

332	2242	3	31.92	78.84	0.03	**838**	11782SG	2	31.32	78.76	0.11
333	2250	3	31.98	78.85	0.17	**839**	11783SG	2	31.32	78.76	0.02
334	2251	3	31.96	78.86	0.05	**840**	11784SG	2	31.32	78.76	0.12
335	2252	3	31.96	78.87	0.06	**841**	11785SG	2	31.32	78.76	0.04
336	2253	3	31.97	78.87	0.31	**842**	11790SG	2	31.32	78.60	0.04
337	2254	3	31.96	78.88	0.09	**843**	11796SG	2	31.26	78.48	0.11
338	2255	3	31.96	78.87	0.09	**844**	12021SG	3	31.37	78.58	0.25
339	2257	2	31.88	78.45	0.04	**845**	193SG	1	32.10	78.87	0.03
340	2259	2	31.82	78.26	0.04	**846**	2144SG	1	31.97	78.37	0.02
341	2260	2	31.81	78.26	0.05	**847**	2145SG	1	31.97	78.37	0.06
342	2263	2	31.62	78.18	0.24	**848**	2146SG	1	31.97	78.37	0.08
343	2264	2	31.61	78.19	0.06	**849**	2148SG	1	31.97	78.39	0.06
344	2265	2	31.61	78.19	0.64	**850**	2149SG	1	31.98	78.38	0.04
345	2266	2	31.58	78.18	0.59	**851**	2196SG	1	31.96	78.71	0.09
346	2267	2	31.59	78.18	0.12	**852**	2200SG	1	31.95	78.72	0.08
347	2268	2	31.58	78.19	6.25	**853**	2207SG	1	31.90	78.70	0.06
348	2270	2	31.44	78.37	0.10	**854**	2209SG	1	31.90	78.70	0.14
349	2273	2	31.43	78.43	0.02	**855**	2210SG	1	31.90	78.70	0.06
350	2278	2	31.43	78.48	0.32	**856**	2211SG	1	31.90	78.70	0.03
351	2288	2	31.56	78.61	1.14	**857**	2212SG	1	31.90	78.70	0.08
352	2289	2	31.52	78.63	0.03	**858**	2213SG	1	31.90	78.71	0.04
353	2290	2	31.52	78.63	0.04	**859**	2215SG	1	31.89	78.72	0.05
354	2295	2	31.48	78.67	0.02	**860**	2269SG	2	31.46	78.37	0.06
355	2296	2	31.47	78.67	0.09	**861**	2271SG	2	31.45	78.39	0.06
356	2297	2	31.47	78.67	0.04	**862**	2272SG	2	31.43	78.43	0.02
357	2298	2	31.48	78.67	0.02	**863**	2274SG	2	31.43	78.45	0.04
358	2299	2	31.47	78.70	0.05	**864**	2275SG	2	31.43	78.45	0.06
359	2300	2	31.56	78.75	0.12	**865**	2276SG	2	31.44	78.45	0.10
360	2302	2	31.55	78.73	0.03	**866**	2277SG	2	31.44	78.45	0.02
361	2303	2	31.55	78.73	0.04	**867**	2279SG	2	31.47	78.43	0.05
362	2304	2	31.53	78.69	0.03	**868**	2280SG	2	31.47	78.43	0.14
363	2305	2	31.57	78.69	0.03	**869**	2281SG	2	31.48	78.44	0.15
364	2306	2	31.68	78.74	0.41	**870**	2282SG	2	31.49	78.43	0.06
365	2308	2	31.40	78.42	0.07	**871**	2283SG	2	31.49	78.43	0.02
366	2311	2	31.40	78.48	0.04	**872**	2284SG	2	31.49	78.43	0.03
367	2312	2	31.41	78.48	1.41	**873**	2285SG	2	31.51	78.44	0.03
368	2339	2	31.35	78.71	0.07	**874**	2286SG	2	31.51	78.44	0.03
369	2341	2	31.36	78.70	0.04	**875**	2287SG	2	31.59	78.57	0.14
370	2342	2	31.36	78.70	0.04	**876**	2309SG	2	31.39	78.44	0.05
371	2343	2	31.36	78.70	0.07	**877**	2310SG	2	31.39	78.44	0.08
372	2344	2	31.36	78.70	0.04	**878**	2314SG	2	31.37	78.58	0.13
373	2345	2	31.36	78.70	1.07	**879**	2317SG	2	31.37	78.58	0.12

374	2346	2	31.36	78.73	0.03	**880**	2318SG	2	31.36	78.58	0.09
375	2347	2	31.38	78.74	0.10	**881**	2320SG	2	31.38	78.61	0.06
376	2348	2	31.38	78.74	0.05	**882**	2324SG	2	31.38	78.62	0.04
377	2349	2	31.37	78.74	0.10	**883**	2326SG	2	31.34	78.65	0.04
378	2350	2	31.33	78.75	0.29	**884**	2327SG	2	31.36	78.66	0.18
379	2351	2	31.33	78.75	0.08	**885**	2328SG	2	31.35	78.66	0.04
380	2352	2	31.33	78.75	0.28	**886**	2329SG	2	31.35	78.66	0.03
381	2353	2	31.32	78.75	0.04	**887**	2332SG	2	31.36	78.68	0.03
382	2354	2	31.32	78.76	0.03	**888**	2336SG	2	31.35	78.68	0.06
383	2354	2	31.32	78.76	0.01	**889**	2337SG	2	31.35	78.68	0.07
384	2355	2	31.32	78.76	0.06	**890**	2338SG	2	31.35	78.68	0.12
385	2356	2	31.32	78.76	1.11	**891**	2365SG	2	31.20	78.75	0.13
386	2357	2	31.32	78.76	0.79	**892**	2374SG	2	31.20	78.73	0.02
387	2358	2	31.30	78.77	0.06	**893**	2375SG	2	31.20	78.73	0.05
388	2359	2	31.30	78.77	0.10	**894**	2376SG	2	31.20	78.72	0.04
389	2360	2	31.29	78.80	0.08	**895**	2377SG	2	31.21	78.72	0.03
390	2363	2	31.28	78.78	1.23	**896**	2381SG	2	31.22	78.70	0.08
391	2364	2	31.24	78.72	0.18	**897**	2391SG	2	31.26	78.65	0.03
392	2382	2	31.22	78.70	0.07	**898**	2392SG	2	31.26	78.65	0.04
393	2386	2	31.25	78.66	0.19	**899**	2402SG	2	31.25	78.62	0.15
394	2387	2	31.24	78.65	0.07	**900**	2403SG	2	31.25	78.61	0.43
395	2388	2	31.24	78.64	0.02	**901**	2406SG	2	31.25	78.61	0.05
396	2393	2	31.27	78.64	0.04	**902**	2406SG	2	31.25	78.61	0.03
397	2422	2	31.31	78.43	0.05	**903**	2406SG	2	31.24	78.61	0.03
398	2423	2	31.31	78.43	0.03	**904**	2407SG	2	31.25	78.61	0.02
399	2424	2	31.31	78.43	0.10	**905**	2411SG	2	31.23	78.48	0.04
400	2428	2	31.32	78.38	1.27	**906**	2413SG	2	31.24	78.47	0.02
401	2430	2	31.31	78.33	0.19	**907**	2416SG	2	31.24	78.48	0.01
402	2431	2	31.31	78.33	0.06	**908**	2417SG	2	31.24	78.48	0.02
403	2432	2	31.31	78.33	0.06	**909**	2419SG	2	31.26	78.47	0.16
404	2433	2	31.31	78.33	0.06	**910**	2421SG	2	31.27	78.50	0.07
405	2434	2	31.31	78.33	0.08	**911**	2429SG	2	31.30	78.37	0.11
406	2435	2	31.31	78.33	0.02	**912**	2492SG	2	31.31	78.60	0.14
407	2436	2	31.31	78.33	0.03	**913**	2493SG	2	31.31	78.60	0.03
408	2437	2	31.31	78.33	0.10	**914**	2494SG	2	31.31	78.60	0.03
409	2438	2	31.31	78.32	0.04	**915**	393SG	1	31.90	78.70	0.05
410	2439	2	31.30	78.31	0.06	**916**	395SG	1	31.90	78.70	0.04
411	2441	2	31.30	78.31	0.40	**917**	396SG	1	31.90	78.70	0.27
412	2444	2	31.36	78.31	0.10	**918**	402SG	1	31.90	78.71	0.07
413	2445	2	31.36	78.31	0.10	**919**	405SG	1	31.89	78.71	0.24
414	2448	2	31.36	78.16	0.39	**920**	406SG	1	31.89	78.72	0.10
415	2449	2	31.36	78.16	0.22	**921**	407SG	1	31.89	78.72	0.09

416	2450	2	31.37	78.16	0.30	**922**	411SG	1	31.89	78.73	0.06
417	2451	2	31.37	78.18	0.22	**923**	446SG	1	31.95	78.72	0.04
418	2452	2	31.38	78.18	0.05	**924**	447SG	1	31.95	78.72	0.04
419	2453	2	31.38	78.18	0.04	**925**	448SG	1	31.95	78.71	0.06
420	2454	2	31.39	78.18	0.15	**926**	450SG	1	31.95	78.71	0.04
421	2455	2	31.38	78.18	0.20	**927**	455SG	1	31.95	78.71	0.11
422	2461	2	31.31	78.79	0.27	**928**	456SG	1	31.96	78.70	0.02
423	2462	2	31.32	78.80	0.05	**929**	457SG	1	31.96	78.70	0.31
424	2465	2	31.36	78.76	0.66	**930**	461SG	1	31.99	78.72	1.10
425	2468	2	31.59	78.18	0.03	**931**	467SG	1	31.97	78.38	0.09
426	2469	2	31.59	78.18	0.39	**932**	468SG	1	31.97	78.38	0.07
427	2471	2	31.48	78.34	0.16	**933**	472SG	1	31.98	78.38	0.07
428	2472	2	31.51	78.73	0.03	**934**	473SG	1	31.97	78.37	0.19
429	2480	2	31.30	78.35	0.04	**935**	474SG	1	31.98	78.37	0.47
430	2483	2	31.33	78.67	0.13	**936**	475SG	1	31.98	78.37	0.10
431	2484	2	31.33	78.67	0.03	**937**	476SG	1	31.98	78.37	0.06
432	2485	2	31.33	78.67	0.05	**938**	477SG	1	31.98	78.37	0.08
433	2486	2	31.33	78.66	0.05	**939**	498SG	2	31.66	78.75	0.03
434	2487	1	31.96	78.47	0.06	**940**	499SG	2	31.66	78.75	0.08
435	2488	2	31.34	78.72	0.05	**941**	501SG	2	31.67	78.75	0.20
436	2489	2	31.32	78.64	0.11	**942**	512SG	2	31.59	78.57	0.06
437	2490	2	31.31	78.62	0.04	**943**	518SG	2	31.58	78.59	0.06
438	2491	2	31.31	78.62	0.04	**944**	583SG	2	31.45	78.36	0.07
439	10399	1	32.33	78.91	2.13	**945**	586SG	2	31.45	78.37	0.03
440	10400	1	32.33	78.90	1.66	**946**	588SG	2	31.44	78.37	0.08
441	10401	1	32.32	78.90	0.04	**947**	589SG	2	31.45	78.37	0.22
442	10404	1	32.33	78.91	2.13	**948**	590SG	2	31.45	78.37	0.14
443	10410	3	32.41	78.84	0.08	**949**	591SG	2	31.45	78.37	0.16
444	10411	3	32.42	78.82	6.69	**950**	592SG	2	31.45	78.37	0.23
445	10412	3	32.42	78.83	0.76	**951**	593SG	2	31.45	78.38	0.14
446	10413	3	32.41	78.83	0.22	**952**	594SG	2	31.46	78.39	0.35
447	10414	1	32.16	78.95	0.16	**953**	595SG	2	31.46	78.39	0.18
448	10415	1	32.16	78.95	0.02	**954**	596SG	2	31.45	78.39	0.05
449	10416	1	32.16	78.94	0.05	**955**	609SG	2	31.41	78.41	0.26
450	10417	1	32.15	78.93	0.22	**956**	610SG	2	31.41	78.41	1.36
451	10418	1	32.15	78.93	0.03	**957**	611SG	2	31.41	78.41	0.14
452	10419	1	32.15	78.93	0.02	**958**	612SG	2	31.42	78.41	0.61
453	10420	1	32.15	78.93	0.02	**959**	620SG	2	31.39	78.44	0.09
454	10421	1	32.17	78.95	0.02	**960**	621SG	2	31.32	78.60	0.19
455	10422	1	32.17	78.95	0.02	**961**	623SG	2	31.31	78.60	0.05
456	10423	1	32.17	78.95	0.11	**962**	647SG	2	31.32	78.76	0.03
457	10424	1	32.19	78.96	2.96	**963**	648SG	2	31.32	78.76	0.04

458	10425	1	32.19	78.97	4.28	**964**	649SG	2	31.32	78.76	0.06
459	10426	1	32.21	78.98	0.30	**965**	655SG	2	31.22	78.71	0.19
460	10427	1	32.22	78.98	0.51	**966**	657SG	2	31.21	78.71	0.32
461	10428	1	32.22	78.98	0.38	**967**	659SG	2	31.21	78.72	0.32
462	10429	1	32.22	78.99	0.29	**968**	660SG	2	31.21	78.72	0.11
463	10430	1	32.22	78.98	0.02	**969**	662SG	2	31.20	78.72	0.85
464	10431	1	32.22	78.99	0.02	**970**	665SG	2	31.20	78.73	0.04
465	10432	1	32.22	78.99	0.02	**971**	675SG	2	31.24	78.61	0.06
466	10433	1	32.22	78.99	0.01	**972**	676SG	2	31.25	78.61	0.08
467	10434	1	32.23	78.98	1.81	**973**	685SG	2	31.25	78.56	0.26
468	10435	1	32.24	78.99	0.14	**974**	686SG	2	31.25	78.55	0.03
469	10436	1	32.24	78.99	0.23	**975**	687SG	2	31.25	78.56	0.06
470	10437	3	32.24	78.99	0.04	**976**	689SG	2	31.23	78.50	0.13
471	10438	1	32.24	78.99	0.04	**977**	692SG	2	31.23	78.48	0.11
472	10439	1	32.25	78.99	0.53	**978**	694SG	2	31.24	78.48	0.06
473	10440	1	32.25	78.99	0.36	**979**	695SG	2	31.24	78.48	0.11
474	10441	1	32.25	78.99	0.04	**980**	697SG	2	31.26	78.48	0.41
475	10442	1	32.26	78.98	2.27	**981**	698SG	2	31.26	78.48	0.21
476	**10443**	**1**	**32.30**	**78.99**	**10.51**	**982**	743RS	3	31.37	78.79	1.49
477	10444	1	32.35	78.88	0.98	**983**	761SG	2	31.35	78.68	0.06
478	10445	1	32.35	78.90	2.34	**984**	765SG	2	31.36	78.68	0.13
479	10446	1	32.35	78.90	0.07	**985**	769SG	2	31.36	78.67	0.05
480	10448	3	32.46	79.13	3.11	**986**	770SG	2	31.36	78.67	0.18
481	10449	3	32.45	79.13	4.21	**987**	771SG	2	31.35	78.66	0.16
482	10450	3	32.45	79.15	0.66	**988**	773SG	2	31.36	78.66	0.11
483	10451	3	32.46	79.15	0.16	**989**	775SG	2	31.38	78.62	0.07
484	10452	3	32.44	79.12	0.30	**990**	778SG	2	31.38	78.61	0.05
485	10453	3	32.44	79.15	0.19	**991**	786SG	2	31.37	78.58	0.29
486	10454	3	32.44	79.15	0.07	**992**	788SG	2	31.36	78.58	0.03
487	10455	3	32.44	79.15	0.04	**993**	790SG	2	31.37	78.58	1.16
488	10456	3	32.44	79.15	0.03	**994**	796SG	2	31.47	78.45	0.04
489	10457	3	32.44	79.15	0.12	**995**	797SG	2	31.45	78.45	0.19
490	10459	3	32.49	79.17	1.84	**996**	799SG	2	31.44	78.45	0.30
491	10461	3	32.49	79.17	0.26	**997**	800SG	2	31.44	78.45	0.21
492	10476	3	32.35	79.10	3.05	**998**	801SG	2	31.44	78.45	0.10
493	10477	3	32.35	79.12	0.36	**999**	803SG	2	31.44	78.45	0.22
494	10478	3	32.35	79.11	0.10	**1000**	805SG	2	31.44	78.45	0.43
495	10480	3	32.36	79.05	0.09	**1001**	810SG	2	31.49	78.44	0.19
496	10482	3	32.36	79.05	0.08	**1002**	811SG	2	31.48	78.42	0.14
497	10483	3	32.35	79.05	4.98	**1003**	812SG	2	31.48	78.41	0.24
498	10484	3	32.35	79.05	0.17	**1004**	814SG	2	31.49	78.43	2.79
499	10485	3	32.35	79.05	0.08	**1005**	816SG	2	31.49	78.43	0.52

500	10486	3	32.34	79.05	0.13	**1006**	819SG	2	31.50	78.43	1.49
501	10487	3	32.34	79.05	0.14	**1007**	820SG	2	31.50	78.43	0.08
502	10488	3	32.34	79.00	3.91	**1008**	821SG	2	31.50	78.43	0.11
503	10490	3	32.33	79.00	2.22	**1009**	822SG	2	31.51	78.43	0.03
504	10491	1	32.32	78.98	7.12	**1010**	824SG	2	31.51	78.43	0.17
505	10492	1	32.33	78.97	6.61	**1011**	825SG	2	31.51	78.43	0.03
506	10493	3	32.39	78.89	1.56	**1012**	826SG	2	31.51	78.44	0.10

HWL= High Altitude Wetland

RS= River Section

SG= Supra Glacier lakes

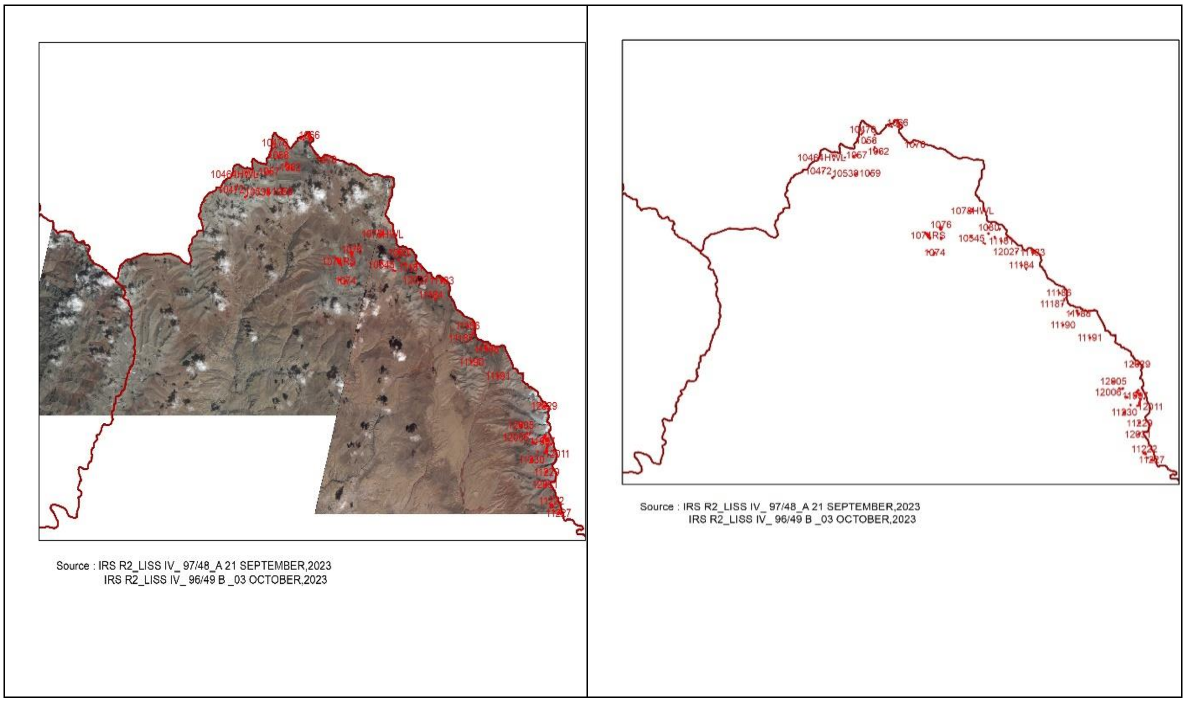


Fig. 9.4 (a) & (b): IRS R2, LISS IV, 97/48 a, 21 September and 97/4b, 03 October and its interpreted layer

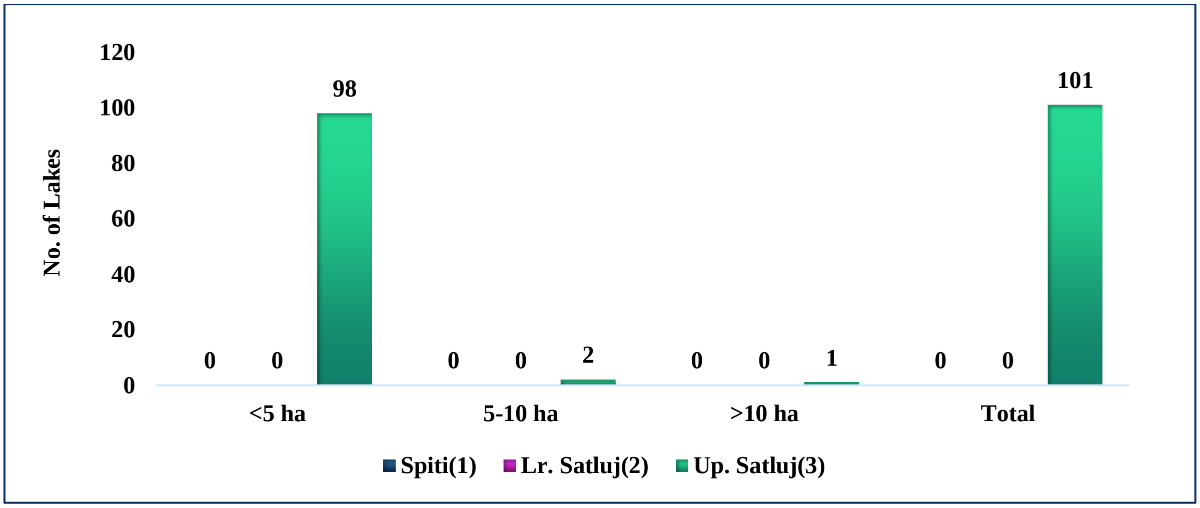


Fig. 9.4 (c): No of lakes based on LISS-IV image 97/48 A & B, 2023

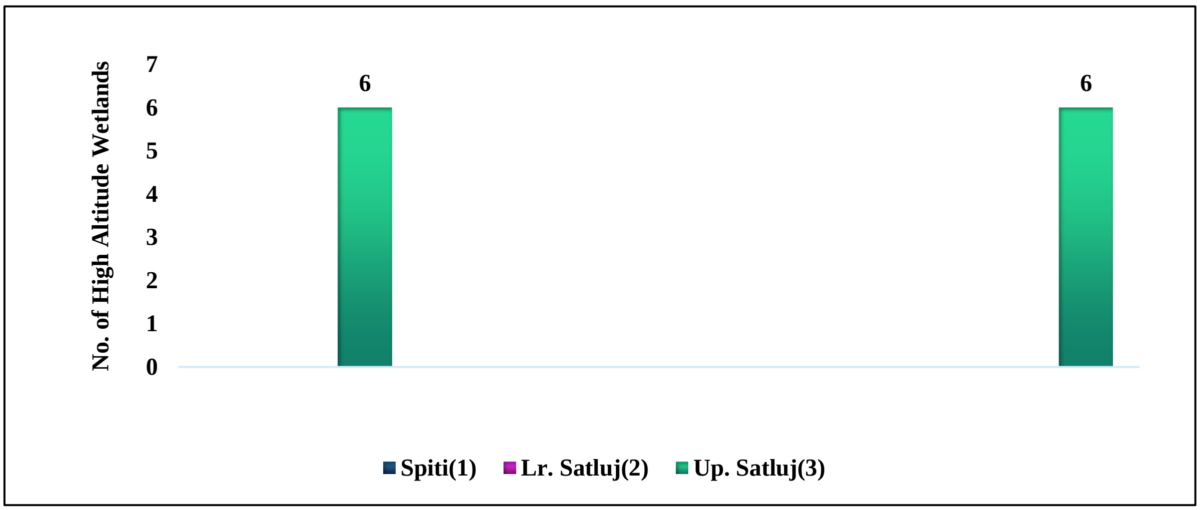


Fig. 9.4 (d): No. of high-altitude wetlands based on LISS-IV image 97/48 A & B, 2023

Table: 9.4 Distribution of Lakes as per satellite data interpretation for 97/48a, 2023 using LISS-IV sensor

S. No.	Basin	Lake	Lat.	Long.	Area Ha (2023)	S. No.	Basin	Lake	Lat.	Long.	Area Ha (2023)
1	3	10402	32.55	79.33	0.05	52	3	11184	32.33	79.57	1.39
2	3	10403	32.52	79.29	0.10	53	3	11185	32.33	79.58	1.02
3	3	10462	32.51	79.21	0.05	54	3	11186	32.29	79.65	0.99
4	3	10463HWL	32.50	79.23	0.07	55	3	11187	32.27	79.65	0.27
5	3	10464HWL	32.50	79.23	0.11	56	3	11188	32.25	79.68	5.84
6	3	10468HWL	32.50	79.25	0.27	57	3	11189	32.25	79.67	0.12
7	3	10469	32.54	79.26	0.23	58	3	11190	32.24	79.65	0.92

8	3	10470	32.54	79.26	0.09	59	3	11191	32.22	79.71	1.58
9	3	10471	32.55	79.31	0.05	60	3	11221	32.02	79.82	0.48
10	3	10472	32.48	79.19	0.10	61	3	11222	32.03	79.81	1.51
11	3	10473	32.47	79.21	0.13	62	3	11227	32.02	79.83	3.27
12	3	10474	32.47	79.21	0.01	63	3	11229	32.08	79.80	3.84
13	3	10475	32.47	79.21	0.02	64	3	11230	32.09	79.77	4.33
14	3	10538	32.48	79.25	0.15	65	3	11231	32.18	79.79	0.72
15	3	10539	32.47	79.25	0.01	66	3	11994	32.10	79.77	0.26
16	3	10540	32.48	79.25	0.10	67	3	11995	32.11	79.80	0.75
17	3	10541	32.48	79.25	0.02	68	3	11996	32.11	79.78	0.31
18	3	10542	32.53	79.28	0.12	69	3	11997	32.12	79.79	4.39
19	3	10545	32.38	79.48	0.23	70	3	11998	32.13	79.80	1.94
20	3	10546	32.37	79.50	0.04	71	3	11999	32.13	79.80	3.45
21	3	10547	32.37	79.50	0.05	72	3	12000	32.13	79.80	0.08
22	3	1057	32.51	79.25	4.44	73	3	12001	32.12	79.80	0.16
23	3	1058	32.53	79.27	1.76	74	3	12002	32.12	79.78	0.64
24	3	1059	32.48	79.28	2.53	75	3	12003	32.12	79.78	0.07
25	3	1060	32.52	79.29	0.73	76	3	12004	32.12	79.77	0.25
26	3	1061	32.52	79.29	0.64	77	3	12005	32.14	79.75	0.97
27	3	1062	32.51	79.29	2.20	78	3	12006	32.13	79.76	0.27
28	3	1063	32.51	79.30	1.06	79	3	12007	32.13	79.77	0.09
29	3	1065	32.55	79.32	0.40	80	3	12008	32.13	79.77	0.52
30	3	1066	32.56	79.33	2.85	81	3	12009	32.13	79.77	0.03
31	3	1067	32.55	79.33	1.43	82	3	12010	32.13	79.80	1.99
32	3	1068	32.55	79.33	0.17	83	3	12011	32.11	79.80	1.84
33	3	1070	32.52	79.36	0.68	84	3	12012	32.11	79.80	0.11
34	**3**	**1071RS**	**32.38**	**79.39**	**23.40**	85	3	12013	32.11	79.80	0.10
35	3	1072	32.35	79.39	0.37	86	3	12014	32.11	79.80	0.09
36	3	1073	32.35	79.40	0.13	87	3	12015	32.11	79.80	0.79
37	3	1074	32.35	79.41	3.97	88	3	12016	32.12	79.80	2.57
38	3	1075	32.37	79.42	2.16	89	3	12017	32.12	79.81	0.12
39	3	1076	32.39	79.42	9.79	90	3	12020	32.02	79.83	0.29
40	3	1077HWL	32.42	79.47	0.37	91	3	12023	32.03	79.81	0.70
41	3	1078HWL	32.42	79.48	0.93	92	3	12024	32.03	79.81	0.10
42	3	1079HWL	32.42	79.48	0.92	93	3	12025	32.03	79.81	0.17
43	3	1080	32.39	79.51	1.79	94	3	12026	32.54	79.29	0.37
44	3	1081	32.38	79.51	1.60	95	3	12027	32.35	79.56	0.51
45	3	1082	32.38	79.52	0.74	96	3	12028	32.26	79.68	2.59
46	3	1083	32.39	79.53	0.59	97	3	12029	32.17	79.80	1.37
47	3	11178	32.38	79.54	0.18	98	3	12031	32.06	79.80	0.72
48	3	11179	32.38	79.54	0.11	99	3	12032	32.28	79.66	0.21
49	3	11180	32.38	79.54	0.03	100	3	12033	32.06	79.80	0.39

50	3	11181	32.37	79.53	2.17	101	3	12034	32.28	79.66	0.06
51	3	11183	32.35	79.59	5.00						

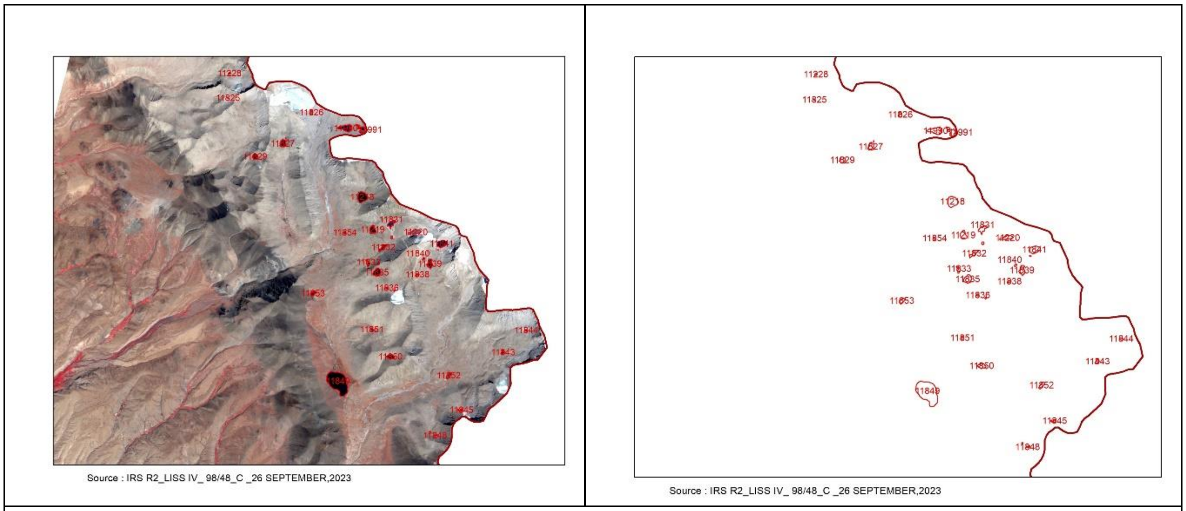


Fig. 9.5 (a) & (b): IRS R2, LISS IV, 98/48 c, 28 September and its interpreted layer

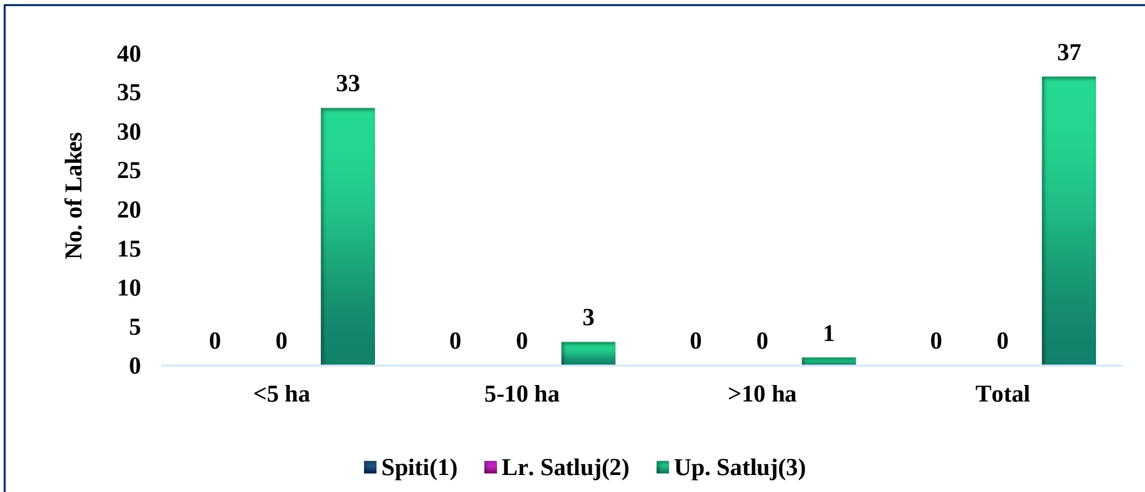


Fig. 9.5 (c) No of lakes based on LISS-IV image 98/48c 2023

Table: 9.5 Distribution of Lakes as per satellite data interpretation for 98/48c, 2023 using LISS-IV sensor

S. No.	Basin	Lake	Lat.	Long	Area Ha (2023)	S. No.	Basin	Lake	Lat.	Long	Area Ha (2023)
1	3	11218	31.98	79.87	7.61	20	3	11840	31.96	79.89	0.39
2	3	11219	31.97	79.88	3.52	21	3	11841	31.96	79.90	5.42
3	3	11220	31.97	79.89	3.02	22	3	11842	31.96	79.90	0.08

4	3	11228	32.01	79.83	0.35	23	3	11843	31.93	79.92	1.06
5	3	11825	32.00	79.83	0.10	24	3	11844	31.94	79.93	0.45
6	3	11826	32.00	79.86	1.15	25	3	11845	31.92	79.91	0.54
7	3	11827	31.99	79.85	3.10	26	3	11846	31.92	79.91	0.21
8	3	11828	31.99	79.85	0.07	27	3	11847	31.91	79.90	0.12
9	3	11829	31.99	79.84	2.48	28	3	11848	31.91	79.90	0.24
10	3	11830	31.97	79.88	0.50	**29**	**3**	**11849**	**31.92**	**79.87**	**34.11**
11	3	11831	31.97	79.88	3.20	30	3	11850	31.93	79.88	2.73
12	3	11832	31.96	79.88	2.24	31	3	11851	31.94	79.88	0.73
13	3	11833	31.96	79.88	0.86	32	3	11852	31.93	79.90	1.73
14	3	11834	31.96	79.87	0.30	33	3	11853	31.95	79.86	1.80
15	3	11835	31.96	79.88	4.37	34	3	11854	31.97	79.87	0.35
16	3	11836	31.95	79.88	0.39	35	3	11990	32.00	79.87	5.96
17	3	11837	31.95	79.88	0.15	36	3	11991	32.00	79.87	3.00
18	3	11838	31.96	79.89	0.41	37	3	11992	32.00	79.87	0.45
19	3	11839	31.96	79.90	3.49						

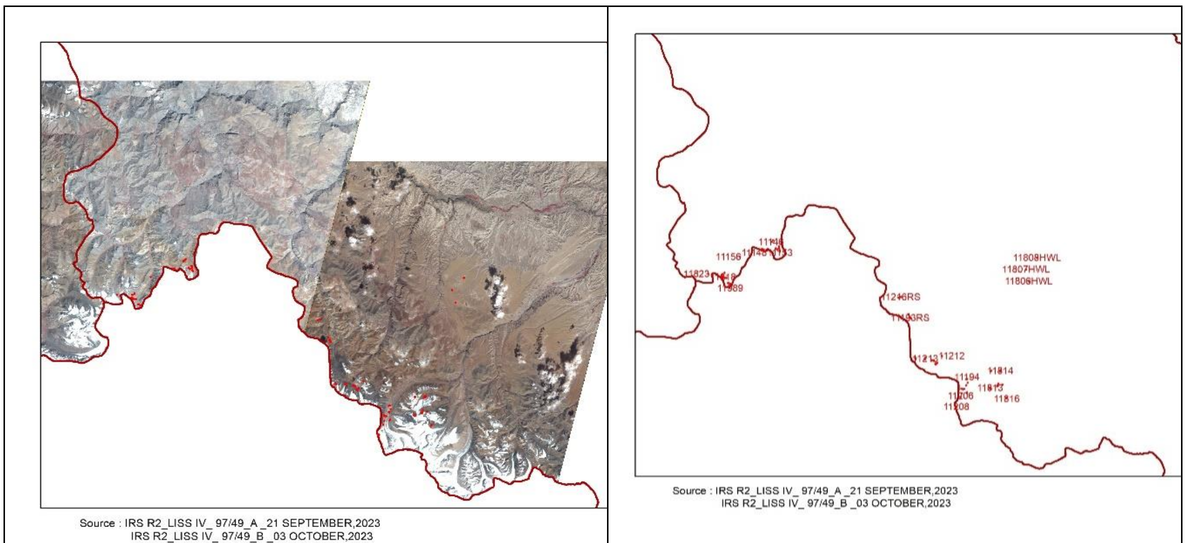


Fig. 9.6 (a) & (b): IRS R2, LISS IV, 97/49a, 21 September and 97/49 b, 03 October 2023 and its interpreted layer

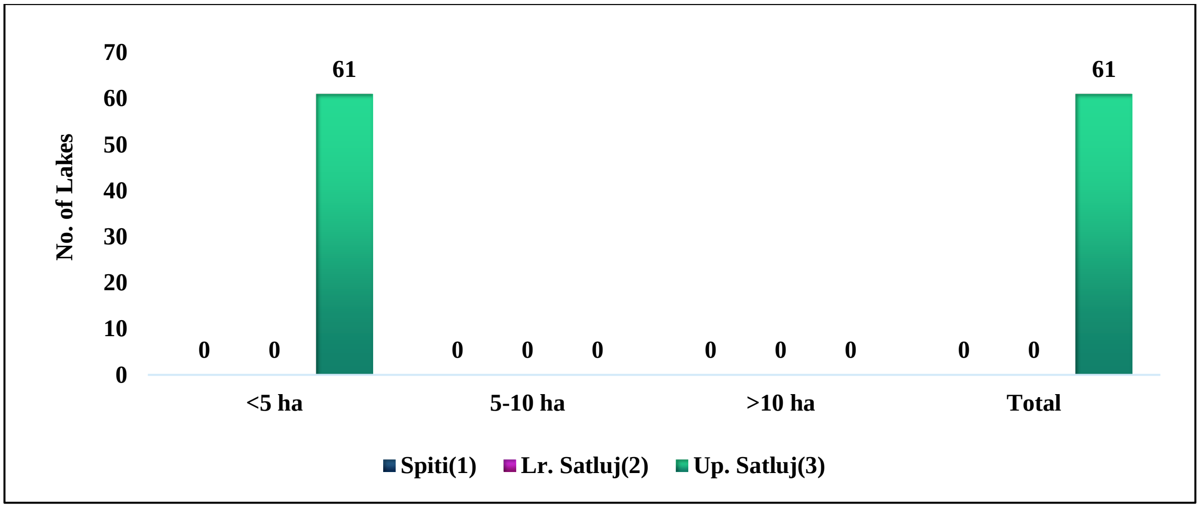


Fig. 9.6 (c): No of lakes based on LISS-IV image 97-49 A & B, 2023

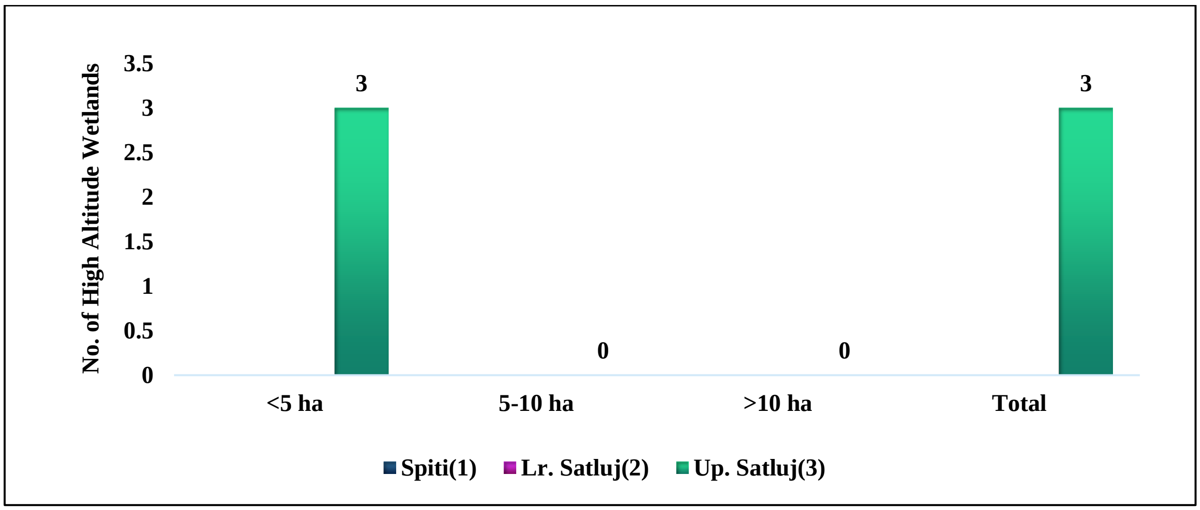


Fig. 9.6 (d): No high wetland lakes based on LISS-IV image 97-49 a & b, 2023

Table: 9.6 Distribution of Lakes as per satellite data interpretation for 97-49 a & b, 2023 using LISS-IV

S. No	Basin	Lake	Lat.	Long.	Area Ha (2023)	S. No	Basin	Lake	Lat.	Long.	Area Ha (2023)
1	1	11146	31.38	31.38	0.37	**32**	3	11216RS	31.27	31.27	0.17
2	3	11147	31.38	31.38	0.17	**33**	3	11217RS	31.27	31.27	0.11
3	3	11148	31.36	31.36	0.17	**34**	3	11209	31.13	31.13	1.26
4	3	11149	31.36	31.36	0.09	**35**	3	11802	31.10	31.10	0.06
5	3	11150	31.36	31.36	0.19	**36**	3	11803	31.10	31.10	0.09

6	3	11151	31.36	31.36	0.13	**37**	3	11804	31.10	31.10	0.08
7	3	11152	31.36	31.36	0.23	**38**	3	11805	31.09	31.09	0.11
8	3	11153	31.36	31.36	0.26	**39**	3	11806HWL	31.31	31.31	0.28
9	3	11154	31.36	31.36	0.07	**40**	3	11807HWL	31.33	31.33	0.05
10	3	11155	31.37	31.37	0.23	**41**	3	11808HWL	31.35	31.35	0.22
11	3	11156	31.35	31.35	0.16	**42**	3	11809	31.10	31.10	1.80
12	3	11193RS	31.23	31.23	4.32	**43**	3	11810	31.10	31.10	0.02
13	3	11194	31.11	31.11	0.42	**44**	3	11811	31.10	31.10	0.01
14	3	11195	31.10	31.10	0.08	**45**	3	1812	31.11	31.11	0.03
15	3	11196	31.09	31.09	0.03	**46**	3	11813	31.10	31.10	2.55
16	3	11198RS	31.24	31.24	0.25	**47**	3	11814	31.13	31.13	4.98
17	3	11199	31.15	31.15	1.14	**48**	3	11815	31.08	31.08	0.03
18	3	11200	31.15	31.15	0.30	**49**	3	11816	31.08	31.08	0.06
19	3	11201	31.11	31.11	0.15	**50**	3	11817	31.08	31.08	0.05
20	3	11202	31.11	31.11	0.07	**51**	3	11818	31.31	31.31	1.38
21	3	11203	31.10	31.10	0.11	**52**	3	11819	31.31	31.31	0.32
22	3	11204	31.09	31.09	0.03	**53**	3	11820	31.30	31.30	0.26
23	3	11205	31.09	31.09	0.19	**54**	3	11821	31.30	31.30	0.06
24	3	11206	31.08	31.08	0.23	**55**	3	11822	31.31	31.31	0.23
25	3	11208	31.06	31.06	2.71	**56**	3	11823	31.31	31.31	0.11
26	3	11210	31.14	31.14	3.39	**57**	3	11824	31.31	31.31	0.04
27	3	11211	31.15	31.15	0.11	**58**	3	11825	31.31	31.31	0.06
28	3	11212	31.16	31.16	0.46	**59**	3	11987	31.29	31.29	0.15
29	3	11213	31.15	31.15	3.57	**60**	3	11988	31.30	31.30	0.18
30	3	11214	31.15	31.15	0.47	**61**	3	11989	31.29	31.29	0.45
31	3	11215	31.15	31.15	0.05						

HWL= High Altitude Wetland

RS= River Section

SG= Supra Glacier lakes

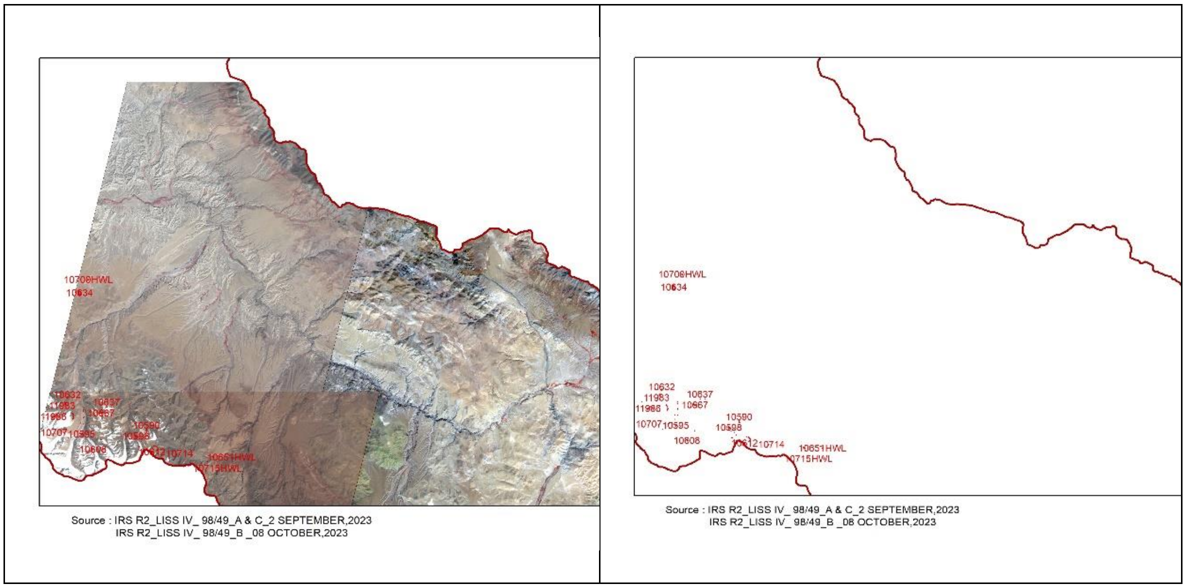


Fig. 9.7 (a) & (b): IRS R2, LISS IV, 98/49 a & c, 2 September and 98-49 b, 08 October, 2023 and its interpreted layer

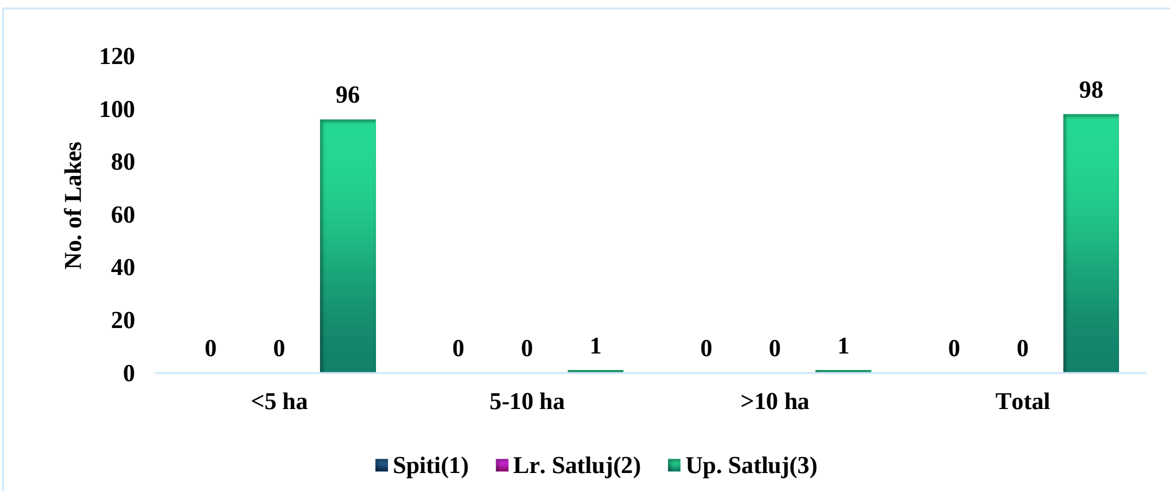


Fig. 9.7(c): No of lakes based on LISS-IV image 98-49 a & c, 2023

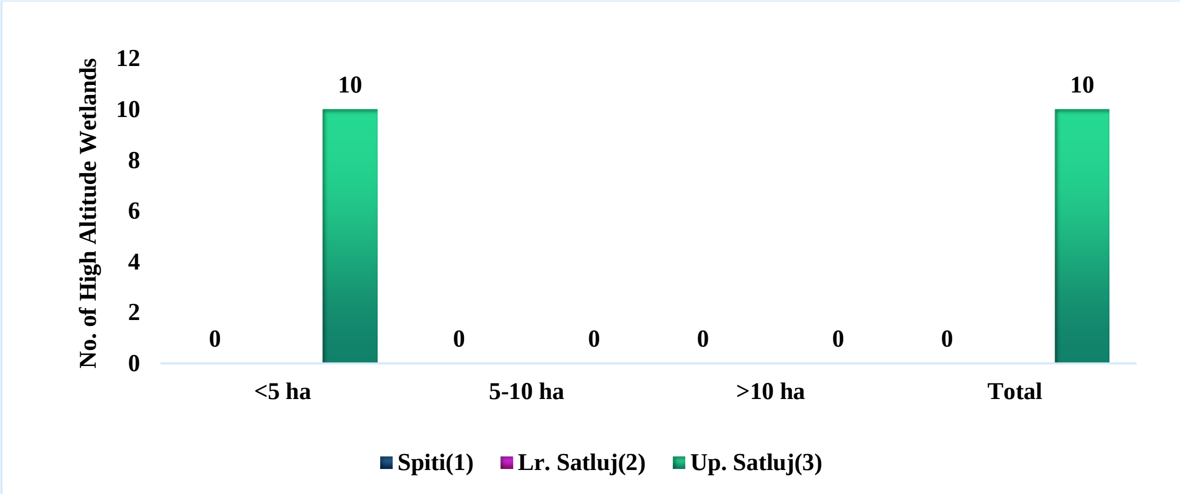


Fig. 9.7 (d): No of lakes based on LISS-IV image 98-49 a& c, 2023

Table: 9.7 Distribution of Lakes as per satellite data interpretation for 98-49 a& c, 2023 using LISS-IV

S. No.	Basin	Lake	Lat.	Long.	Area Ha (2023)	S. No.	Basin	Lake	Lat.	Long	Area Ha (2023)
1	3	10581	31.07	31.07	0.19	50	3	10651HWL	30.99	30.99	0.78
2	3	10582	31.07	31.07	0.11	51	3	10652HWL	30.99	30.99	0.07
3	3	10583	31.07	31.07	0.09	52	3	10653HWL	30.99	30.99	0.08
4	3	10584	31.06	31.06	0.10	53	3	10654HWL	30.99	30.99	0.05
5	3	10585	31.06	31.06	0.06	54	3	10655HWL	30.99	30.99	0.03
6	3	10586	31.06	31.06	0.15	55	3	10656	30.99	30.99	0.21
7	3	10587	31.06	31.06	0.22	56	3	10657	31.01	31.01	0.35
8	3	10588	31.05	31.05	0.07	57	3	10658	31.01	31.01	0.13
9	3	10589	31.04	31.04	0.12	58	3	10660	31.01	31.01	0.05
10	3	10590	31.04	31.04	3.83	59	3	10661	31.01	31.01	0.16
11	3	10591	31.04	31.04	0.03	60	3	10663	31.01	31.01	0.03
12	3	10592	31.04	31.04	0.02	61	3	10664	31.02	31.02	0.10
13	3	10594	31.04	31.04	0.06	62	3	10665	31.02	31.02	0.02
14	3	10595	31.03	31.03	1.28	63	3	10667	31.07	31.07	1.30
15	3	10596	31.03	31.03	0.05	64	3	10668	31.05	31.05	0.15
16	3	10597	31.03	31.03	0.11	65	3	10670	31.07	31.07	0.03
17	3	10598	31.03	31.03	7.26	66	3	10671	31.08	31.08	0.05
18	3	10602	31.01	31.01	0.13	67	3	10672	31.08	31.08	0.04
19	3	10603	31.01	31.01	0.03	68	3	10673	31.08	31.08	0.01
20	3	10606SC	31.01	31.01	0.24	69	3	10674	31.07	31.07	0.04

21	3	10608	31.00	31.00	0.07	70	3	10675	31.07	31.07	0.03
22	3	10609	31.00	31.00	0.27	71	3	10676	31.06	31.06	0.01
23	3	10610	31.00	31.00	0.02	72	3	10678	31.06	31.06	0.02
24	3	10612	31.00	31.00	0.85	73	3	10679	31.06	31.06	0.02
25	3	10613	30.99	30.99	0.15	74	3	10681	31.07	31.07	0.03
26	3	10622	31.09	31.09	0.10	75	3	10685	31.06	31.06	0.03
27	3	10623	31.09	31.09	0.05	76	3	10687	31.07	31.07	0.01
28	3	10624	31.09	31.09	0.04	77	3	10688	31.07	31.07	0.04
29	3	10626	31.06	31.06	0.16	78	3	10693	31.07	31.07	0.20
30	3	10628	31.04	31.04	0.03	79	3	10698	31.08	31.08	0.03
31	3	10629	31.02	31.02	0.02	80	3	10700HWL	31.33	31.33	1.63
32	3	10630	31.02	31.02	0.06	81	3	10701HWL	31.33	31.33	0.16
33	3	10632	31.10	31.10	0.10	82	3	10704	31.03	31.03	0.03
34	3	10633	31.10	31.10	0.04	83	3	10705	31.03	31.03	0.03
35	**3**	**10634**	**31.30**	**31.30**	**31.91**	84	3	10706	31.03	31.03	0.02
36	3	10636	31.08	31.08	0.12	85	3	10707	31.03	31.03	0.07
37	3	10637	31.08	31.08	0.29	86	3	10714	31.00	31.00	0.33
38	3	10638	31.08	31.08	0.04	87	3	10715HWL	30.97	30.97	0.05
39	3	10640	31.08	31.08	0.06	88	3	10621	31.09	31.09	0.12
40	3	10641	31.08	31.08	0.03	89	3	10621	31.09	31.09	0.07
41	3	10642	31.07	31.07	0.08	90	3	10621	31.09	31.09	0.12
42	3	10643	31.07	31.07	0.71	91	3	11979	31.09	31.09	0.03
43	3	10644	31.07	31.07	0.25	92	3	11980	31.09	31.09	0.03
44	3	10645	31.07	31.07	0.23	93	3	11981	31.09	31.09	0.03
45	3	10646	31.07	31.07	0.07	94	3	11982	31.06	31.06	0.03
46	3	10647	31.07	31.07	0.06	95	3	11983	31.08	31.08	0.18
47	3	10648	31.07	31.07	0.08	96	3	11984	31.08	31.08	0.04
48	3	10649HWL	30.99	30.99	0.62	97	3	11985	31.07	31.07	0.01
49	3	10650HWL	30.99	30.99	0.53	98	3	11986	31.06	31.06	0.39

HWL= High Altitude Wetland

RS= River Section

SG= Supra Glacier lakes

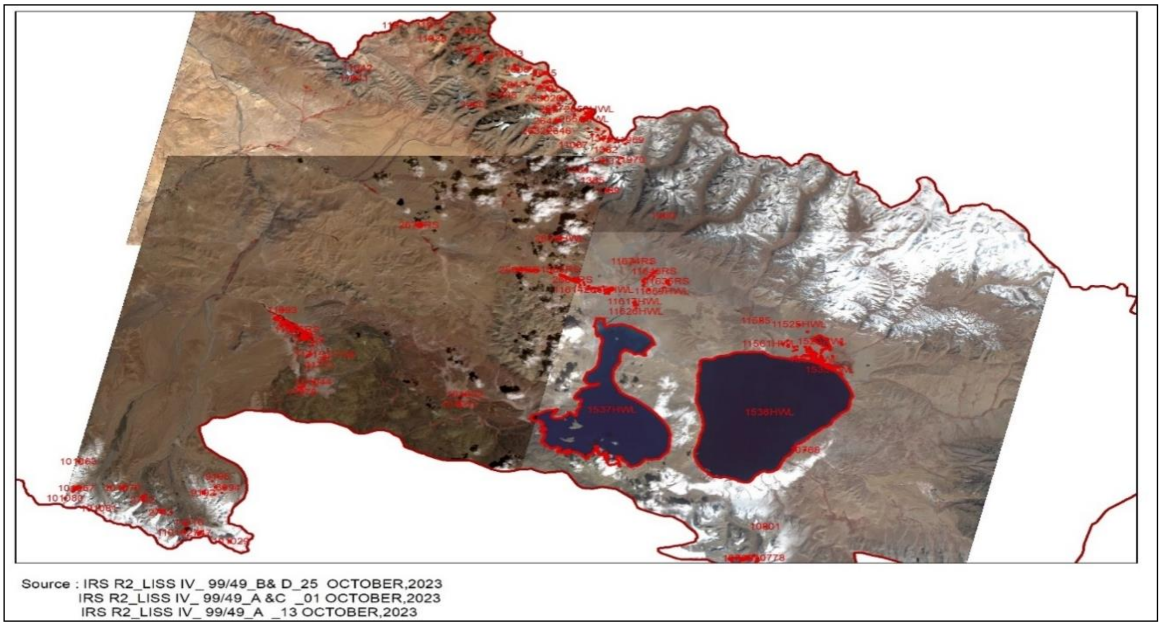


Fig. 9.8 (a): IRS R2, LISS IV, 99/49 a, b, c & d of 2023 and its interpreted layer

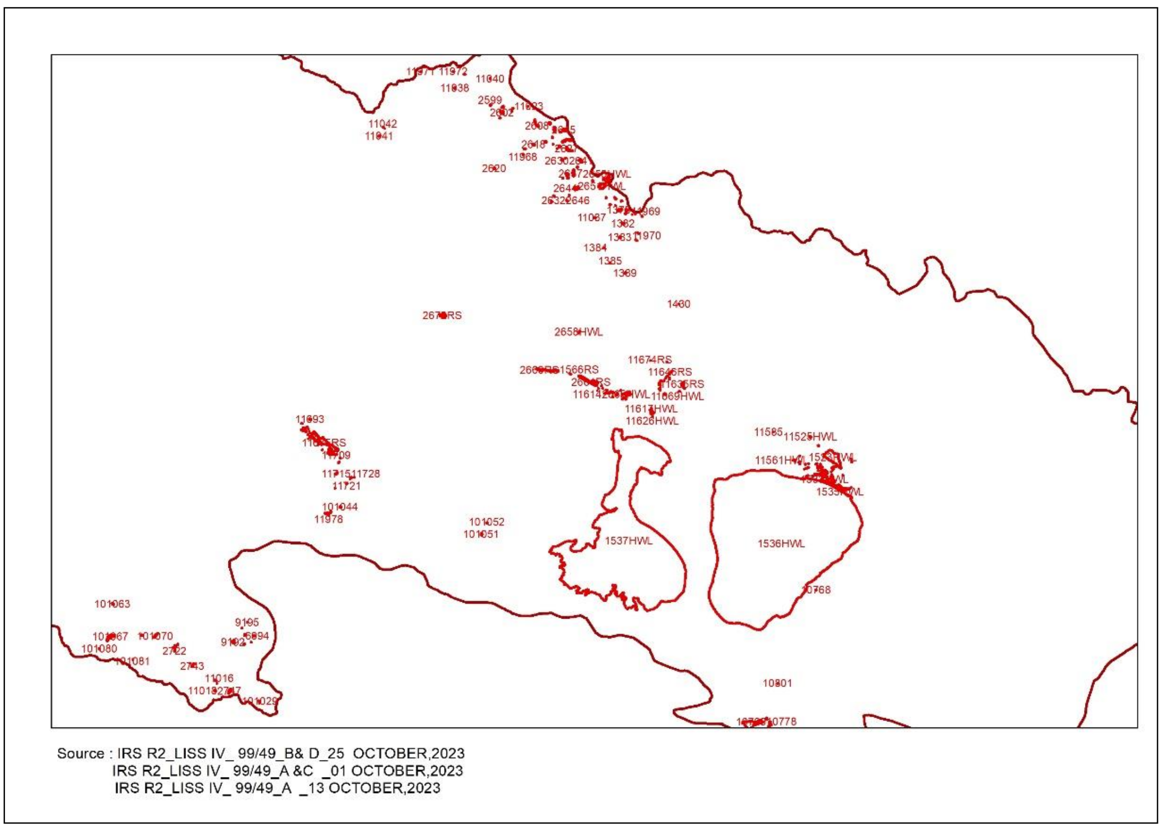


Fig. 9.8 (b): IRS R2, LISS IV, 99/49 a, b, c & d of 2023 and its interpreted layer

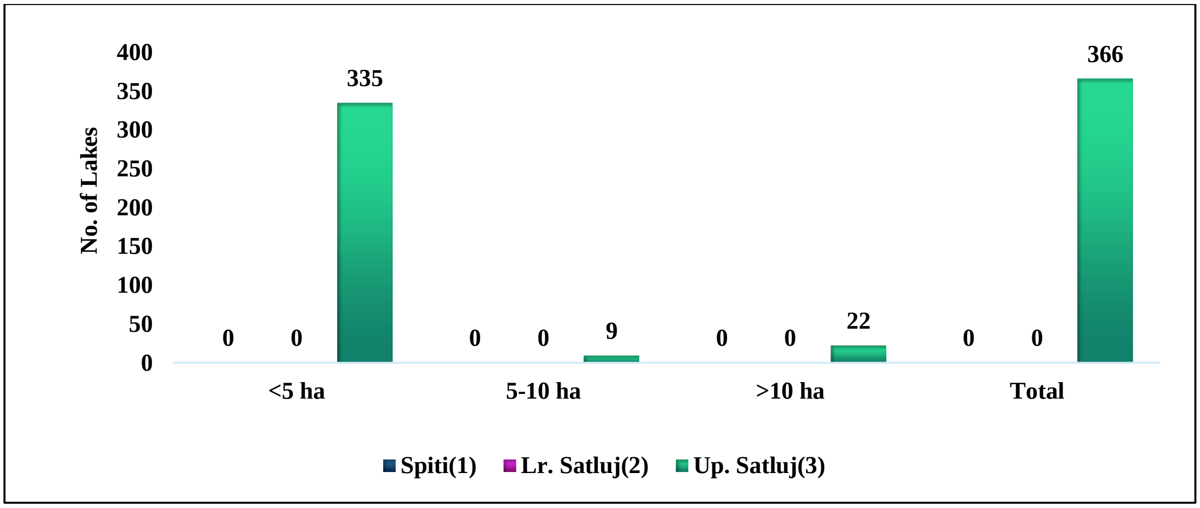


Fig. 9.8 (c): No. of lakes based on 99/49 a, b, c, & d, LISS IV, 2023

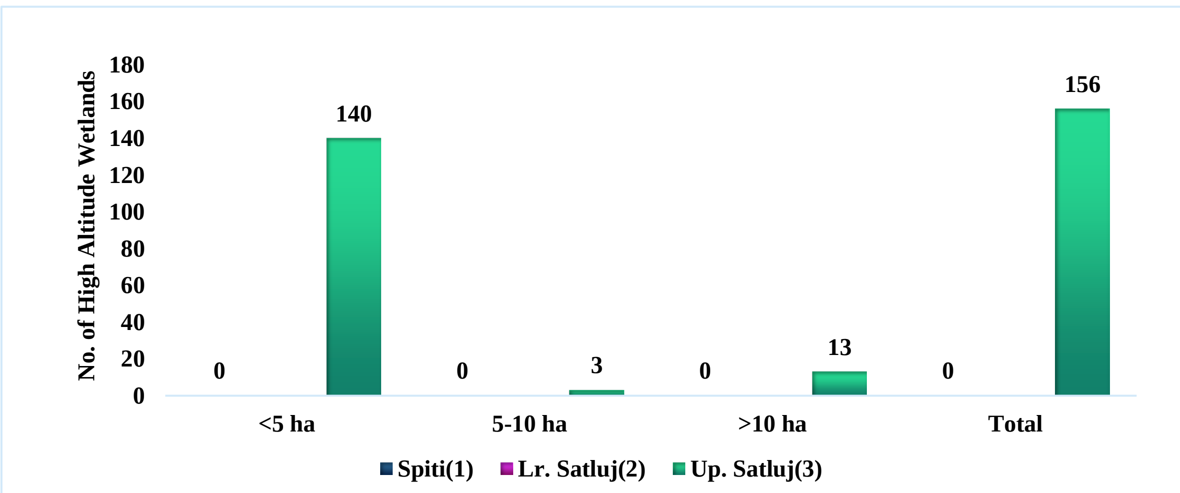


Fig. 9.8 (d): No. of High-Altitude Wetlands for 99/49 a, b, c, & d, LISS IV, 2023

Table: 9.8 Distribution of Lakes as per satellite data interpretation for 99/49a, b, c, & d 2023 using LISS-IV

S. No.	Basin	Lake	Lat.	Long.	Area Ha (2023)	S. No.	Basin	Lake	Lat.	Long.	Area Ha (2023)
1	3	1371	31.16	31.16	2.15	184	3	11969	31.14	31.14	0.95
2	3	1372	31.16	31.16	1.15	185	3	11970	31.12	31.12	0.89
3	3	1375	31.15	31.15	8.24	186	3	11971	31.34	31.34	0.66
4	3	1376	31.15	31.15	1.96	187	3	11972	31.34	31.34	0.46
5	3	1377	31.15	31.15	0.53	188	3	11973	31.37	31.37	1.39

6	3	1378	31.15	31.15	0.32	189	3	11974	30.72	30.72	2.22
7	3	1379	31.15	31.15	0.11	190	3	11975	30.73	30.73	0.98
8	3	1380	31.15	31.15	0.47	191	3	11976	30.73	30.73	0.55
9	3	1381	31.14	31.14	0.41	192	3	11977	30.73	30.73	0.75
10	3	1382	31.13	31.13	4.49	193	3	11978	30.72	30.72	0.12
11	3	1383	31.11	31.11	2.17	194	3	101029	30.46	30.46	0.89
12	3	1384	31.10	31.10	0.29	195	3	101030	30.46	30.46	0.09
13	3	1385	31.07	31.07	0.50	196	3	101044	30.73	30.73	2.87
14	3	1389	31.06	31.06	2.67	197	3	101051	30.70	30.70	4.50
15	3	1390	31.11	31.11	0.35	198	3	101052	30.71	30.71	1.05
16	3	1430	31.02	31.02	0.19	199	3	101063	30.60	30.60	2.93
17	3	2599	31.29	31.29	2.42	200	3	101064	30.55	30.55	1.91
18	3	2601	31.29	31.29	3.77	201	3	101065	30.55	30.55	2.75
19	**3**	**2602**	**31.28**	**31.28**	**14.86**	202	3	101066	30.55	30.55	0.94
20	3	2603	31.28	31.28	1.22	**203**	**3**	**101067**	**30.55**	**30.55**	**26.13**
21	3	2604	31.29	31.29	0.56	204	3	101068	30.55	30.55	1.87
22	3	2605	31.29	31.29	1.00	205	3	101069	30.55	30.55	0.10
23	3	2607	31.27	31.27	1.56	206	3	101070	30.55	30.55	7.96
24	3	2608	31.27	31.27	4.87	207	3	101071	30.56	30.56	0.44
25	3	2609	31.27	31.27	0.62	208	3	101072	30.56	30.56	0.08
26	3	2610	31.27	31.27	3.18	209	3	101080	30.53	30.53	0.90
27	3	2611	31.26	31.26	1.74	210	3	101081	30.52	30.52	0.43
28	3	2612	31.26	31.26	4.05	211	3	11525HWL	30.83	30.83	3.44
29	3	2613	31.25	31.25	1.31	212	3	11526HWL	30.80	30.80	0.47
30	3	2614	31.26	31.26	0.23	213	3	11527HWL	30.80	30.80	0.29
31	**3**	**2615**	**31.26**	**31.26**	**13.21**	214	3	11528HWL	30.79	30.79	0.16
32	3	2616	31.24	31.24	0.25	215	3	11529HWL	30.79	30.79	0.42
33	3	2617	31.24	31.24	3.68	216	3	11530HWL	30.79	30.79	0.49
34	3	2618	31.24	31.24	4.24	217	3	11531HWL	30.79	30.79	0.20
35	3	2619	31.23	31.23	2.27	218	3	11532HWL	30.78	30.78	0.21
36	3	2620	31.21	31.21	2.19	219	3	11533HWL	30.78	30.78	6.55
37	3	2621	31.23	31.23	0.13	220	3	11534HWL	30.78	30.78	1.04
38	3	2622	31.24	31.24	3.20	221	3	11535HWL	30.78	30.78	0.37
39	3	2623	31.24	31.24	2.89	222	3	11536HWL	30.78	30.78	0.56
40	3	2624	31.24	31.24	3.80	223	3	11537HWL	30.78	30.78	1.51
41	3	2625	31.25	31.25	9.37	224	3	11538HWL	30.78	30.78	0.36
42	**3**	**2627**	**31.23**	**31.23**	**10.25**	225	3	11539HWL	30.78	30.78	0.19
43	3	2628	31.23	31.23	1.91	226	3	11540HWL	30.78	30.78	0.12
44	3	2629	31.22	31.22	0.32	227	3	11541HWL	30.78	30.78	0.30

45	3	2630	31.22	31.22	0.97	228	3	11542HWL	30.78	30.78	0.18
46	3	2631	31.16	31.16	1.73	229	3	11543HWL	30.78	30.78	0.26
47	3	2632	31.17	31.17	1.77	230	3	11544HWL	30.80	30.80	1.37
48	3	2633	31.19	31.19	0.45	231	3	11545HWL	30.80	30.80	0.19
49	3	2634	31.20	31.20	0.12	232	3	11546HWL	30.77	30.77	0.36
50	3	2635	31.20	31.20	0.04	233	3	11547HWL	30.77	30.77	0.09
51	3	2636	31.19	31.19	6.24	234	3	11548HWL	30.77	30.77	0.32
52	**3**	**2637**	**31.20**	**31.20**	**10.63**	235	3	11549HWL	30.77	30.77	0.92
53	3	2638	31.20	31.20	0.71	236	3	11550HWL	30.77	30.77	0.07
54	3	2639	31.21	31.21	1.43	237	3	11551HWL	30.77	30.77	0.27
55	3	2640	31.22	31.22	0.16	238	3	11552HWL	30.78	30.78	0.21
56	3	2641	31.22	31.22	8.42	239	3	11553HWL	30.78	30.78	0.06
57	3	2642	31.19	31.19	1.50	240	3	11554HWL	30.78	30.78	0.06
58	3	2643	31.18	31.18	0.05	241	3	11555HWL	30.78	30.78	0.04
59	**3**	**2644**	**31.18**	**31.18**	**20.99**	242	3	11556HWL	30.78	30.78	0.11
60	3	2645	31.17	31.17	0.59	243	3	11557HWL	30.78	30.78	0.66
61	3	2646	31.16	31.16	0.60	244	3	11558HWL	30.78	30.78	0.17
62	3	2647	31.16	31.16	0.15	245	3	11560HWL	30.78	30.78	0.35
63	3	2652	31.19	31.19	0.89	246	3	11561HWL	30.80	30.80	1.14
64	3	2654	31.17	31.17	0.70	247	3	11562HWL	30.80	30.80	0.24
65	3	2656	31.16	31.16	0.41	248	3	11563HWL	30.80	30.80	0.16
66	3	2669	31.18	31.18	0.31	249	3	11564HWL	30.80	30.80	0.15
67	3	2670	31.18	31.18	0.56	250	3	11565HWL	30.79	30.79	0.30
68	3	2676	30.51	30.51	0.98	251	3	11566HWL	30.79	30.79	0.20
69	3	2689	30.54	30.54	0.08	252	3	11567HWL	30.79	30.79	0.37
70	3	2695	30.55	30.55	0.12	253	3	11568HWL	30.79	30.79	0.06
71	3	2703	30.54	30.54	0.42	254	3	11569HWL	30.79	30.79	0.14
72	3	2709	30.54	30.54	0.29	255	3	11570HWL	30.79	30.79	0.19
73	3	2715	30.54	30.54	0.09	256	3	11571HWL	30.79	30.79	0.16
74	3	2718	30.54	30.54	0.23	257	3	11572HWL	30.79	30.79	0.06
75	3	2719	30.54	30.54	0.06	258	3	11573HWL	30.79	30.79	0.14
76	3	2722	30.53	30.53	1.57	259	3	11574HWL	30.79	30.79	0.12
77	3	2727	30.54	30.54	0.14	260	3	11575HWL	30.79	30.79	3.75
78	3	2738	30.51	30.51	1.45	261	3	11576HWL	30.79	30.79	0.89
79	3	2740	30.51	30.51	0.09	262	3	11577HWL	30.79	30.79	0.11
80	3	2743	30.51	30.51	2.12	263	3	11578HWL	30.79	30.79	0.09
81	**3**	**2747**	**30.48**	**30.48**	**14.27**	264	3	11579HWL	30.78	30.78	0.17
82	3	6094	30.55	30.55	1.33	265	3	11580HWL	30.78	30.78	0.08
83	3	9166	30.54	30.54	0.69	266	3	11581HWL	30.78	30.78	0.07

84	3	9192	30.54	30.54	7.81	267	3	11582HWL	30.79	30.79	0.15
85	3	9193	30.55	30.55	0.94	268	3	11583HWL	30.79	30.79	0.06
86	3	9194	30.56	30.56	1.31	269	3	11584HWL	30.79	30.79	0.06
87	3	9195	30.57	30.57	0.21	270	3	11586HWL	30.89	30.89	0.69
88	3	9240	30.52	30.52	0.36	271	3	11587HWL	30.90	30.90	0.76
89	3	10768	30.62	30.62	0.17	272	3	11590HWL	30.89	30.89	2.43
90	**3**	**10769**	**30.43**	**30.43**	**196.92**	273	3	11591HWL	30.89	30.89	0.22
91	3	10770	30.44	30.44	3.31	274	3	11592HWL	30.89	30.89	0.08
92	3	10778	30.43	30.43	0.11	275	3	11593HWL	30.89	30.89	0.23
93	**3**	**10779**	**30.43**	**30.43**	**16.68**	276	3	11594HWL	30.89	30.89	0.25
94	3	10801	30.49	30.49	0.59	277	3	11595HWL	30.89	30.89	0.19
95	3	11013	30.56	30.56	0.07	278	3	11596HWL	30.89	30.89	0.13
96	3	11014	30.54	30.54	0.15	279	3	11597HWL	30.89	30.89	0.37
97	3	11015	30.49	30.49	0.09	280	3	11598HWL	30.89	30.89	2.34
98	3	11016	30.49	30.49	0.42	281	3	11599HWL	30.90	30.90	0.21
99	3	11017	30.49	30.49	0.13	282	3	11604HWL	30.89	30.89	0.30
100	3	11018	30.48	30.48	3.50	283	3	11605HWL	30.88	30.88	0.29
101	3	11019	30.49	30.49	0.09	284	3	11606HWL	30.88	30.88	0.65
102	3	11020	30.49	30.49	0.42	285	3	11607HWL	30.89	30.89	0.56
103	3	11021	30.49	30.49	0.13	286	3	11608HWL	30.89	30.89	0.15
104	3	11023	31.29	31.29	0.21	287	3	11609HWL	30.89	30.89	0.12
105	3	11024	31.22	31.22	0.81	288	3	11610HWL	30.89	30.89	0.09
106	3	11037	31.14	31.14	1.45	289	3	11611HWL	30.89	30.89	0.23
107	3	11038	31.32	31.32	1.93	290	3	11612HWL	30.89	30.89	0.56
108	3	11039	31.34	31.34	0.29	291	3	11616RS	30.91	30.91	0.68
109	3	11040	31.33	31.33	0.29	292	3	11617HWL	30.87	30.87	0.71
110	3	11041	31.25	31.25	3.28	293	3	11618HWL	30.87	30.87	0.68
111	3	11042	31.26	31.26	0.26	294	3	11619HWL	30.87	30.87	0.43
112	3	11074	31.29	31.29	0.19	295	3	11620HWL	30.87	30.87	0.27
113	3	11585	30.84	30.84	0.17	296	3	11621HWL	30.87	30.87	0.25
114	3	11588	30.90	30.90	0.16	297	3	11622HWL	30.86	30.86	0.65
115	3	11589	30.90	30.90	0.22	298	3	11623HWL	30.86	30.86	0.48
116	3	11613	30.90	30.90	0.13	299	3	11624HWL	30.87	30.87	0.20
117	3	11614	30.90	30.90	0.10	300	3	11625HWL	30.87	30.87	0.17
118	3	11630	30.90	30.90	0.16	301	3	11626HWL	30.86	30.86	0.18
119	3	11631	30.89	30.89	0.08	302	3	11627HWL	30.86	30.86	0.09
120	3	11632	30.89	30.89	0.04	303	3	11628HWL	30.87	30.87	0.09
121	3	11656	30.91	30.91	2.49	304	3	11629RS	30.91	30.91	1.05
122	3	11657	30.91	30.91	0.48	305	3	11633RS	30.90	30.90	0.76

123	3	11658	30.91	30.91	0.25	306	3	11634RS	30.90	30.90	0.49
124	3	11659	30.91	30.91	0.09	307	3	11635RS	30.91	30.91	4.52
125	3	11660	30.91	30.91	0.08	308	3	11636RS	30.91	30.91	0.15
126	3	11664	30.91	30.91	0.08	309	3	11637RS	30.91	30.91	0.13
127	3	11665	30.91	30.91	0.04	310	3	11638RS	30.90	30.90	0.15
128	3	11668	30.90	30.90	0.29	311	3	11639RS	30.90	30.90	0.07
129	3	11672	30.90	30.90	0.55	312	3	11641RS	30.90	30.90	0.12
130	3	11673	30.90	30.90	0.77	313	3	11642RS	30.90	30.90	0.07
131	3	11676	30.84	30.84	0.53	314	3	11643RS	30.90	30.90	0.05
132	3	11677	30.84	30.84	0.23	315	3	11644RS	30.90	30.90	0.09
133	3	11678	30.82	30.82	0.21	316	3	11645RS	30.90	30.90	0.04
134	3	11679	30.82	30.82	0.26	317	3	11646RS	30.92	30.92	0.34
135	3	11681	30.83	30.83	0.19	318	3	11647RS	30.92	30.92	0.15
136	3	11682	30.83	30.83	0.16	319	3	11648RS	30.92	30.92	0.14
137	3	11683	30.83	30.83	0.05	320	3	11649RS	30.92	30.92	0.22
138	3	11684	30.83	30.83	0.15	321	3	11650RS	30.92	30.92	0.27
139	3	11685	30.83	30.83	0.06	322	3	11651RS	30.92	30.92	0.06
140	3	11686	30.84	30.84	0.29	323	3	11652RS	30.92	30.92	0.30
141	3	11687	30.84	30.84	0.13	324	3	11653RS	30.92	30.92	0.16
142	3	11688	30.84	30.84	0.05	325	3	11654RS	30.92	30.92	0.19
143	3	11689	30.84	30.84	0.07	326	3	11655RS	30.92	30.92	0.08
144	3	11690	30.84	30.84	0.09	327	3	11661RS	30.91	30.91	0.27
145	3	11692	30.84	30.84	0.08	328	3	11662RS	30.91	30.91	0.08
146	3	11693	30.86	30.86	2.28	329	3	11663RS	30.91	30.91	0.26
147	3	11694	30.85	30.85	0.58	330	3	11669HWL	30.89	30.89	0.75
148	3	11695	30.84	30.84	0.09	331	3	11670HWL	30.89	30.89	0.39
149	3	11696	30.84	30.84	0.50	332	3	11671HWL	30.94	30.94	0.20
150	3	11697	30.84	30.84	0.12	333	3	11674RS	30.94	30.94	0.29
151	3	11698	30.84	30.84	0.09	334	**3**	**11675RS**	**30.82**	**30.82**	**288.09**
152	3	11699	30.84	30.84	0.09	335	3	1522HWL	30.82	30.82	1.19
153	3	11700	30.83	30.83	0.05	336	**3**	**1523HWL**	**30.80**	**30.80**	**333.21**
154	3	11701	30.84	30.84	0.05	337	3	1524HWL	30.79	30.79	1.69
155	3	11702	30.84	30.84	0.06	338	3	1525HWL	30.79	30.79	5.63
156	3	11703	30.84	30.84	0.09	339	3	1526HWL	30.78	30.78	2.47
157	3	11704	30.85	30.85	0.09	340	3	1527HWL	30.78	30.78	4.67
158	3	11705	30.85	30.85	0.09	341	3	1528HWL	30.78	30.78	6.24
159	3	11706	30.81	30.81	0.24	342	3	1530HWL	30.78	30.78	0.33
160	3	11708	30.81	30.81	0.13	343	3	1531HWL	30.78	30.78	1.52
161	3	11709	30.81	30.81	0.76	344	**3**	**1533HWL**	**30.77**	**30.77**	**62.54**

162	3	11710	30.80	30.80	0.43	345	**3**	**1534HWL**	**30.77**	**30.77**	**13.49**
163	3	11711	30.80	30.80	0.14	346	**3**	**1535HWL**	**30.76**	**30.76**	**43.09**
164	3	11714	30.78	30.78	0.47	347	**3**	**1536HWL**	**30.68**	**30.68**	**41665.17**
165	3	11715	30.78	30.78	1.16	348	**3**	**1537HWL**	**30.69**	**30.69**	**25777.35**
166	3	11716	30.78	30.78	0.24	349	3	1566RS	30.92	30.92	0.63
167	3	11719	30.76	30.76	0.13	350	3	1567HWL	30.89	30.89	0.34
168	3	11721	30.77	30.77	0.30	351	3	1568HWL	30.89	30.89	1.00
169	3	11722	30.77	30.77	0.14	352	3	1569HWL	30.89	30.89	1.19
170	3	11723	30.77	30.77	0.05	353	3	1570HWL	30.89	30.89	1.67
171	3	11725	30.78	30.78	0.12	354	3	1571HWL	30.89	30.89	1.31
172	3	11726	30.77	30.77	1.08	355	**3**	**2651HWL**	**31.18**	**31.18**	**51.87**
173	3	11727	30.77	30.77	0.55	356	**3**	**2653HWL**	**31.19**	**31.19**	**30.01**
174	3	11728	30.78	30.78	0.17	357	3	2658HWL	30.98	30.98	2.48
175	3	11730	30.80	30.80	0.16	358	3	2659HWL	30.98	30.98	1.15
176	0	11960	31.26	31.26	0.06	359	**3**	**2660RS**	**30.93**	**30.93**	**17.48**
177	0	11961	31.14	31.14	0.31	360	3	2661RS	30.92	30.92	2.16
178	0	11962	31.14	31.14	0.33	361	3	2662RS	30.92	30.92	1.98
179	0	11963	31.11	31.11	0.21	362	**3**	**2663RS**	**30.92**	**30.92**	**11.88**
180	0	11964	31.16	31.16	0.10	363	**3**	**2664RS**	**30.91**	**30.91**	**88.82**
181	0	11966	31.15	31.15	0.08	364	3	2665HWL	30.89	30.89	2.30
182	0	11967	31.29	31.29	0.11	365	3	2666HWL	30.89	30.89	0.43
183	0	11968	31.23	31.23	0.74	366	**3**	**2672RS**	**31.00**	**31.00**	**29.59**

HWL= High Altitude Wetland
RS= River Section
SG= Supra Glacier lakes

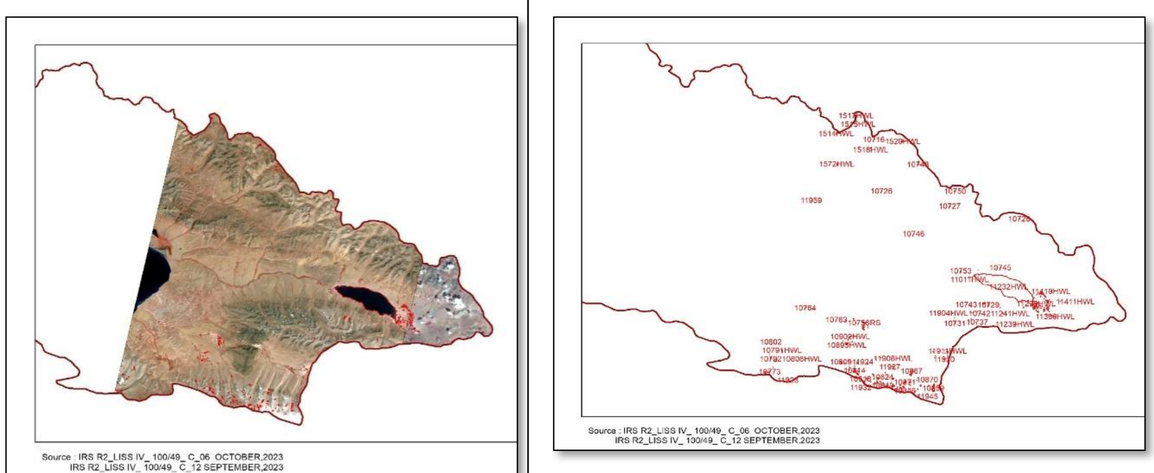


Fig 9.9 (a) & (b): IRS R2, LISS IV, 100/49 c & d of 2023 and its interpreted layer

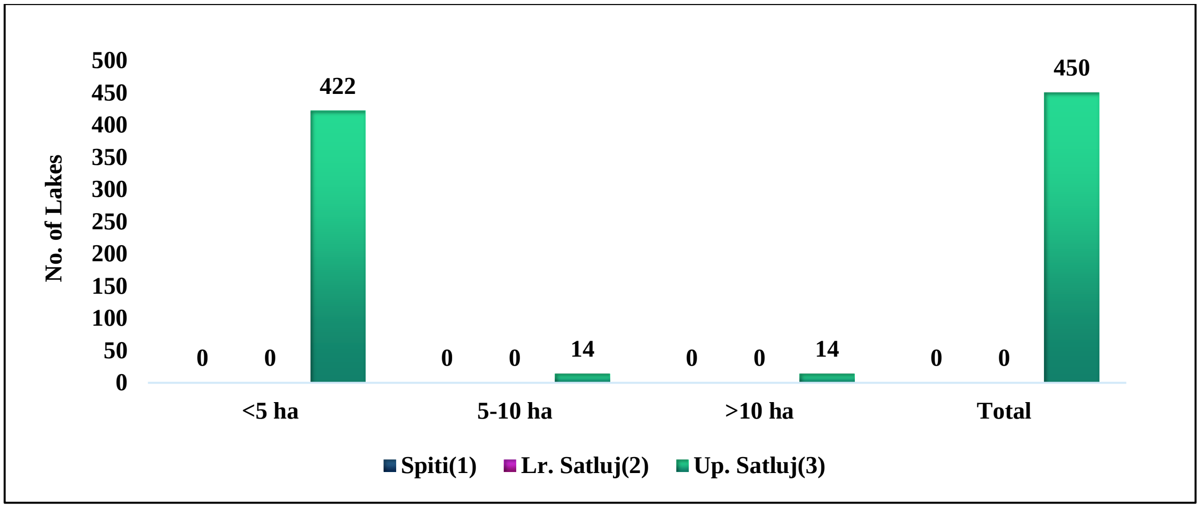


Fig. 9.9 (c): No. of lakes based on LISS-IV image 100/49 C, 2023

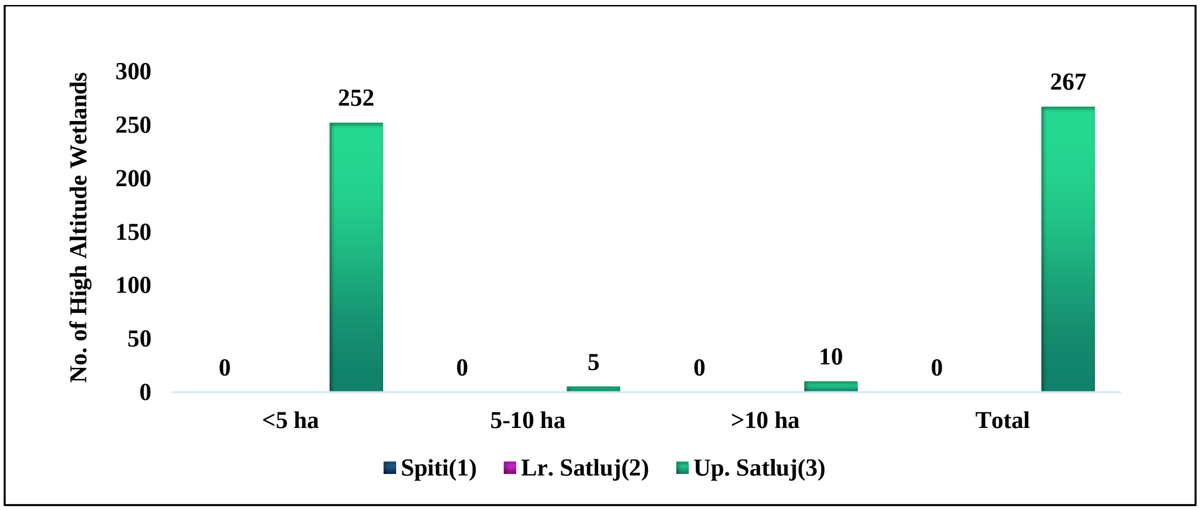


Fig. 9.9 (d): No of High-Altitude wetlands lakes based on LISS-IV image 100/49 C, 2023

Table: 9.9 Distribution of Lakes as per satellite data interpretation for 100/49 (a, b, c and d) 2023 using LISS-IV sensor.

S. No.	Basin	Lake	Lat.	Long.	Area Ha (2023)	S. No	Basin	Lake	Lat.	Long.	Area Ha (2023)
1	3	10716	31.01	31.01	0.23	226	3	11261HWL	30.58	30.58	2.62
2	3	10717	30.95	30.95	0.17	227	3	11262HWL	30.58	30.58	1.59
3	3	10718	30.95	30.95	0.07	228	3	11263HWL	30.58	30.58	1.82
4	3	10723	31.03	31.03	0.24	229	3	11264HWL	30.58	30.58	1.52
5	3	10724	31.03	31.03	0.41	230	3	11265HWL	30.59	30.59	0.58
6	3	10726	30.88	30.88	0.84	231	3	11266HWL	30.59	30.59	0.22

7	3	10727	30.84	30.84	3.11	232	3	11267HWL	30.59	30.59	0.58
8	3	10728	30.81	30.81	2.01	233	3	11268HWL	30.60	30.60	1.41
9	**3**	**10729**	**30.59**	**30.59**	**14.02**	234	3	11269HWL	30.60	30.60	0.45
10	**3**	**10730**	**30.60**	**30.60**	**12.60**	235	3	11270HWL	30.60	30.60	2.49
11	3	10731	30.55	30.55	2.98	236	3	11271HWL	30.60	30.60	0.26
12	3	10732	30.55	30.55	0.26	237	3	11272HWL	30.60	30.60	0.24
13	3	10733	30.55	30.55	0.81	238	3	11273HWL	30.60	30.60	0.41
14	3	10734	30.55	30.55	0.06	239	3	11274HWL	30.60	30.60	0.19
15	3	10735	30.55	30.55	0.06	240	3	11275HWL	30.60	30.60	0.07
16	3	10736	30.56	30.56	0.31	241	3	11276HWL	30.60	30.60	0.29
17	3	10737	30.56	30.56	0.34	242	3	11277HWL	30.60	30.60	0.27
18	3	10738	30.57	30.57	0.37	243	3	11278HWL	30.60	30.60	0.26
19	3	10739	30.57	30.57	0.22	244	3	11279HWL	30.60	30.60	0.23
20	3	10740	30.58	30.58	0.15	245	3	11280HWL	30.60	30.60	0.10
21	3	10741	30.57	30.57	0.42	246	3	11281HWL	30.60	30.60	0.11
22	3	10742	30.57	30.57	1.05	247	3	11282HWL	30.60	30.60	0.12
23	3	10743	30.59	30.59	0.11	248	3	11283HWL	30.60	30.60	0.22
24	3	10744	30.59	30.59	0.08	249	3	11284HWL	30.62	30.62	0.74
25	3	10745	30.69	30.69	1.69	250	3	11285HWL	30.62	30.62	0.20
26	3	10746	30.77	30.77	0.65	251	3	11286HWL	30.62	30.62	0.24
27	3	10747	30.95	30.95	4.28	252	3	11287HWL	30.62	30.62	0.21
28	3	10748	30.95	30.95	5.45	253	3	11288HWL	30.62	30.62	0.40
29	3	10750	30.88	30.88	0.56	254	3	11289HWL	30.62	30.62	0.11
30	3	10751	30.88	30.88	0.48	255	3	11290HWL	30.62	30.62	0.40
31	3	10752	30.88	30.88	0.23	256	3	11292HWL	30.62	30.62	0.12
32	3	10753	30.68	30.68	0.76	257	3	11293HWL	30.62	30.62	0.08
33	3	10754	30.67	30.67	0.18	258	3	11294HWL	30.62	30.62	0.26
34	3	10762	30.55	30.55	0.38	259	3	11295HWL	30.62	30.62	0.09
35	3	10763	30.56	30.56	2.32	260	3	11296HWL	30.62	30.62	0.14
36	3	10764	30.59	30.59	0.38	261	3	11297HWL	30.62	30.62	0.06
37	3	10765	30.59	30.59	0.36	262	3	11298HWL	30.62	30.62	0.15
38	3	10766	30.59	30.59	0.17	263	3	11302HWL	30.62	30.62	0.39
39	3	10767	30.59	30.59	0.07	264	3	11303HWL	30.62	30.62	0.34
40	3	10772	30.43	30.43	0.26	265	3	11304HWL	30.62	30.62	0.24
41	3	10773	30.43	30.43	2.32	266	3	11305HWL	30.62	30.62	0.63
42	3	10774	30.43	30.43	1.43	267	3	11306HWL	30.62	30.62	0.07
43	3	10775	30.43	30.43	0.13	268	3	11307HWL	30.62	30.62	0.21
44	3	10776	30.43	30.43	0.54	269	3	11308HWL	30.62	30.62	0.13
45	3	10777	30.43	30.43	2.30	270	3	11309HWL	30.62	30.62	0.04

46	3	10789	30.44	30.44	0.12	271	3	11310HWL	30.62	30.62	0.33
47	3	10792	30.46	30.46	2.49	272	3	11311HWL	30.61	30.61	0.40
48	3	10793	30.46	30.46	0.25	273	3	11312HWL	30.61	30.61	0.18
49	3	10794	30.46	30.46	0.04	274	3	11314HWL	30.61	30.61	0.18
50	3	10795	30.47	30.47	0.04	275	3	11316HWL	30.61	30.61	0.09
51	3	10796	30.46	30.46	0.24	276	3	11317HWL	30.61	30.61	0.44
52	3	10798	30.47	30.47	0.18	277	3	11318HWL	30.61	30.61	0.73
53	3	10799	30.47	30.47	0.08	278	3	11319HWL	30.61	30.61	0.21
54	3	10802	30.50	30.50	0.93	279	3	11320HWL	30.58	30.58	0.71
55	3	10803	30.45	30.45	1.66	280	3	11321HWL	30.58	30.58	0.08
56	3	10804	30.45	30.45	0.41	281	3	11322HWL	30.58	30.58	0.15
57	3	10805	30.45	30.45	0.20	282	3	11323HWL	30.58	30.58	0.37
58	3	10806	30.45	30.45	0.07	283	3	11324HWL	30.57	30.57	0.12
59	3	10807	30.46	30.46	2.26	284	3	11325HWL	30.57	30.57	0.29
60	3	10809	30.45	30.45	8.49	285	3	11326HWL	30.57	30.57	0.25
61	3	10810	30.45	30.45	2.07	286	3	11327HWL	30.58	30.58	0.23
62	3	10811	30.44	30.44	0.78	287	3	11328HWL	30.58	30.58	0.21
63	3	10812	30.43	30.43	4.34	288	3	11329HWL	30.58	30.58	0.10
64	3	10813	30.43	30.43	3.20	289	3	11330HWL	30.58	30.58	0.09
65	**3**	**10814**	**30.43**	**30.43**	**24.61**	290	3	11331HWL	30.59	30.59	1.21
66	**3**	**10815**	**30.42**	**30.42**	**20.01**	291	3	11332HWL	30.58	30.58	0.19
67	3	10816	30.42	30.42	3.61	292	3	11333HWL	30.58	30.58	0.10
68	3	10818	30.41	30.41	9.17	293	3	11334HWL	30.58	30.58	0.15
69	3	10819	30.40	30.40	4.56	294	3	11335HWL	30.58	30.58	0.72
70	3	10820	30.40	30.40	0.16	295	3	11336HWL	30.59	30.59	0.35
71	3	10822	30.40	30.40	0.40	296	3	11337HWL	30.59	30.59	0.18
72	3	10823	30.41	30.41	1.36	297	3	11338HWL	30.59	30.59	0.20
73	3	10824	30.41	30.41	7.24	298	3	11339HWL	30.59	30.59	0.19
74	3	10825	30.40	30.40	6.15	299	3	11340HWL	30.59	30.59	0.38
75	3	10826	30.39	30.39	0.33	300	3	11342HWL	30.58	30.58	0.07
76	3	10827	30.40	30.40	0.68	301	3	11343HWL	30.58	30.58	0.09
77	3	10828	30.40	30.40	2.93	302	3	11344HWL	30.58	30.58	0.05
78	3	10829	30.40	30.40	1.08	303	3	11345HWL	30.58	30.58	0.79
79	3	10830	30.40	30.40	0.65	304	3	11346HWL	30.58	30.58	0.11
80	3	10831	30.40	30.40	5.60	305	3	11348HWL	30.58	30.58	0.13
81	3	10834	30.39	30.39	0.20	306	3	11349HWL	30.58	30.58	0.29
82	3	10835	30.39	30.39	0.31	307	3	11350HWL	30.58	30.58	0.23
83	3	10836	30.40	30.40	4.06	308	3	11351HWL	30.59	30.59	0.84
84	3	10837	30.39	30.39	0.70	309	3	11352HWL	30.59	30.59	0.33

85	3	10838	30.39	30.39	0.92	310	3	11353HWL	30.59	30.59	0.48
86	3	10839	30.39	30.39	0.29	311	3	11354HWL	30.57	30.57	0.64
87	**3**	**10840**	**30.39**	**30.39**	**15.53**	312	3	11355HWL	30.57	30.57	0.71
88	3	10841	30.39	30.39	1.10	313	3	11356HWL	30.56	30.56	0.28
89	3	10842	30.39	30.39	0.36	314	3	11359HWL	30.56	30.56	1.92
90	3	10843	30.39	30.39	0.21	315	3	11360HWL	30.56	30.56	3.29
91	3	10844	30.38	30.38	0.49	316	3	11361HWL	30.56	30.56	0.10
92	3	10845	30.38	30.38	3.16	317	3	11362HWL	30.57	30.57	0.13
93	**3**	**10846**	**30.38**	**30.38**	**12.71**	318	3	11363HWL	30.57	30.57	0.44
94	3	10847	30.39	30.39	3.77	319	3	11364HWL	30.57	30.57	0.18
95	3	10848	30.39	30.39	0.32	320	3	11365HWL	30.57	30.57	0.40
96	3	10849	30.39	30.39	0.05	321	3	11370HWL	30.58	30.58	0.11
97	3	10850	30.39	30.39	0.36	322	3	11372HWL	30.59	30.59	0.51
98	3	10851	30.39	30.39	0.10	323	3	11373HWL	30.59	30.59	0.24
99	3	10852	30.39	30.39	1.69	324	3	11374HWL	30.60	30.60	0.17
100	3	10853	30.38	30.38	2.96	325	3	11375HWL	30.60	30.60	0.16
101	3	10854	30.38	30.38	0.06	326	3	11376HWL	30.59	30.59	0.36
102	3	10855	30.38	30.38	0.13	327	3	11377HWL	30.60	30.60	0.07
103	3	10857	30.38	30.38	0.14	328	3	11378HWL	30.66	30.66	0.55
104	3	10858	30.38	30.38	0.26	329	3	11379HWL	30.66	30.66	0.16
105	**3**	**10859**	**30.38**	**30.38**	**70.78**	330	3	11382HWL	30.62	30.62	0.14
106	3	10860	30.39	30.39	0.75	331	3	11383HWL	30.62	30.62	0.10
107	3	10861	30.39	30.39	0.06	332	3	11384HWL	30.62	30.62	0.09
108	3	10862	30.39	30.39	0.37	333	3	11385HWL	30.62	30.62	0.31
109	3	10863	30.38	30.38	0.09	334	3	11386HWL	30.62	30.62	0.18
110	3	10864	30.38	30.38	0.12	335	3	11387HWL	30.62	30.62	0.13
111	3	10865	30.39	30.39	0.46	336	3	11388HWL	30.62	30.62	0.14
112	3	10866	30.38	30.38	0.09	337	3	11389HWL	30.62	30.62	0.07
113	**3**	**10867**	**30.43**	**30.43**	**22.25**	338	3	11390HWL	30.62	30.62	0.14
114	**3**	**10868**	**30.42**	**30.42**	**14.58**	339	3	11391HWL	30.62	30.62	0.13
115	3	10869	30.42	30.42	0.18	340	3	11392HWL	30.62	30.62	0.07
116	3	10870	30.40	30.40	1.77	341	3	11393HWL	30.62	30.62	0.12
117	**3**	**10871**	**30.40**	**30.40**	**16.15**	342	3	11394HWL	30.59	30.59	0.32
118	3	10872	30.40	30.40	8.97	343	3	11395HWL	30.59	30.59	0.24
119	3	10873	30.39	30.39	0.92	344	3	11397HWL	30.58	30.58	0.05
120	3	10874	30.39	30.39	0.20	345	3	11398HWL	30.58	30.58	0.23
121	3	10877	30.40	30.40	0.49	346	3	11399HWL	30.58	30.58	0.09
122	3	10878	30.38	30.38	1.84	347	3	11400HWL	30.59	30.59	0.51
123	3	10879	30.38	30.38	0.26	348	3	11401HWL	30.60	30.60	0.24

124	**3**	**10880**	**30.39**	**30.39**	**10.29**	349	3	11402HWL	30.60	30.60	0.09
125	3	10881	30.39	30.39	0.62	350	3	11403HWL	30.60	30.60	0.14
126	3	10882	30.39	30.39	0.32	351	3	11404HWL	30.60	30.60	0.16
127	3	10883	30.39	30.39	0.07	352	3	11405HWL	30.61	30.61	0.07
128	3	10884	30.41	30.41	7.05	353	3	11406HWL	30.61	30.61	0.05
129	3	10885	30.41	30.41	0.09	354	3	11407HWL	30.61	30.61	0.04
130	3	10886	30.42	30.42	0.07	355	3	11408HWL	30.61	30.61	0.07
131	3	10888	30.42	30.42	1.69	356	3	11409HWL	30.61	30.61	0.04
132	3	10890	30.40	30.40	0.13	357	3	11409HWL	30.61	30.61	0.07
133	3	10891	30.45	30.45	0.15	358	3	11409HWL	30.61	30.61	0.07
134	3	10892	30.45	30.45	0.06	359	3	11409HWL	30.61	30.61	0.07
135	0	11918	30.42	30.42	0.29	360	3	11410HWL	30.62	30.62	2.03
136	0	11919	30.42	30.42	0.16	361	3	11411HWL	30.60	30.60	0.19
137	0	11920	30.43	30.43	0.38	362	3	11412HWL	30.60	30.60	0.07
138	0	11921	30.43	30.43	0.35	363	3	11413HWL	30.60	30.60	0.04
139	0	11923	30.41	30.41	0.35	364	3	11414HWL	30.58	30.58	0.19
140	0	11924	30.45	30.45	6.52	365	3	11415HWL	30.58	30.58	0.20
141	0	11925	30.44	30.44	0.26	366	3	11416HWL	30.58	30.58	0.74
142	0	11926	30.44	30.44	0.17	367	3	11417HWL	30.58	30.58	0.32
143	0	11927	30.44	30.44	4.06	368	3	11418HWL	30.58	30.58	0.35
144	0	11928	30.44	30.44	0.37	369	3	11501HWL	30.68	30.68	0.23
145	0	11929	30.44	30.44	0.19	370	3	11503HWL	30.68	30.68	0.07
146	0	11930	30.45	30.45	1.77	371	3	11504RS	30.54	30.54	0.35
147	0	11931	30.43	30.43	0.70	372	3	11505RS	30.53	30.53	0.67
148	0	11932	30.39	30.39	0.21	373	3	11506RS	30.53	30.53	0.21
149	0	11933	30.39	30.39	0.04	374	3	11507RS	30.54	30.54	1.51
150	0	11934	30.38	30.38	0.60	375	3	11510RS	30.54	30.54	0.72
151	0	11935	30.38	30.38	0.22	376	3	11511RS	30.54	30.54	0.79
152	0	11936	30.39	30.39	0.08	377	3	11512RS	30.54	30.54	0.09
153	0	11938	30.39	30.39	0.04	378	3	11513RS	30.54	30.54	0.06
154	0	11939	30.39	30.39	0.11	379	3	11514RS	30.54	30.54	1.35
155	0	11940	30.41	30.41	0.12	380	3	11515RS	30.54	30.54	0.13
156	0	11941	30.41	30.41	0.06	381	3	11516RS	30.53	30.53	0.25
157	0	11942	30.41	30.41	0.06	382	3	11517RS	30.53	30.53	0.29
158	0	11945	30.37	30.37	1.00	383	3	11518RS	30.54	30.54	0.14
159	0	11946	30.37	30.37	0.10	384	3	11519RS	30.54	30.54	0.22
160	0	11947	30.37	30.37	0.06	385	3	11520RS	30.54	30.54	0.24
161	0	11948	30.38	30.38	1.17	386	3	11521RS	30.53	30.53	0.23
162	0	11949	30.40	30.40	0.11	387	3	11522RS	30.53	30.53	0.25

163	0	11950	30.46	30.46	1.83	388	3	11523RS	30.53	30.53	0.15
164	0	11951	30.46	30.46	0.09	389	3	11524RS	30.53	30.53	0.47
165	0	11952	30.47	30.47	0.08	390	0	11855HWL	30.60	30.60	0.11
166	0	11953	30.48	30.48	0.13	391	0	11856HWL	30.60	30.60	0.08
167	0	11954	30.48	30.48	0.13	392	0	11857HWL	30.60	30.60	0.04
168	0	11956	30.48	30.48	0.46	393	0	11858HWL	30.60	30.60	0.06
169	0	11957	30.95	30.95	0.63	394	0	11860HWL	30.60	30.60	0.09
170	0	11959	30.86	30.86	0.10	395	0	11861HWL	30.60	30.60	0.08
171	3	11901HW	30.51	30.51	0.63	396	0	11862HWL	30.62	30.62	0.06
172	3	10755HW	30.56	30.56	2.40	397	0	11863HWL	30.62	30.62	0.06
173	**3**	**10756RS**	**30.55**	**30.55**	**15.05**	398	0	11864HWL	30.62	30.62	0.06
174	3	10757HW	30.55	30.55	0.67	399	3	11866HWL	30.61	30.61	0.08
175	3	10758HW	30.54	30.54	0.71	400	3	11867HWL	30.61	30.61	0.18
176	3	10759HW	30.54	30.54	0.10	401	0	11868HWL	30.58	30.58	0.11
177	3	10760HW	30.54	30.54	0.08	402	0	11869HWL	30.59	30.59	0.08
178	3	10761HW	30.55	30.55	2.23	403	0	11870HWL	30.58	30.58	0.16
179	3	10790HW	30.48	30.48	3.22	404	0	11871HWL	30.59	30.59	0.26
180	3	10791HW	30.48	30.48	7.49	405	0	11875HWL	30.58	30.58	0.33
181	3	10800HW	30.48	30.48	0.36	406	0	11876HWL	30.58	30.58	0.06
182	3	10808HW	30.46	30.46	1.09	407	0	11877HWL	30.58	30.58	0.06
183	3	10895HW	30.50	30.50	2.06	408	0	11878HWL	30.59	30.59	0.09
184	3	10896HW	30.50	30.50	0.35	409	0	11881HWL	30.58	30.58	0.10
185	3	10897HW	30.50	30.50	1.77	410	0	11882HWL	30.57	30.57	0.09
186	3	10898HW	30.50	30.50	0.32	411	0	11884HWL	30.57	30.57	0.07
187	3	10899HW	30.50	30.50	0.09	412	0	11885HWL	30.57	30.57	0.09
188	3	10900HW	30.50	30.50	1.67	413	0	11886HWL	30.60	30.60	0.31
189	3	10902HW	30.51	30.51	9.03	414	0	11887HWL	30.59	30.59	0.09
190	3	10903HW	30.49	30.49	0.63	415	0	11888HWL	30.59	30.59	0.10
191	3	10909HW	30.50	30.50	0.21	416	0	11889HWL	30.59	30.59	0.09
192	3	11000HW	30.50	30.50	0.05	417	0	11891HWL	30.58	30.58	0.07
193	3	11001HW	30.51	30.51	0.05	418	0	11892HWL	30.57	30.57	0.06
194	3	11007HW	30.52	30.52	0.07	419	0	11893HWL	30.59	30.59	0.17
195	3	11010HW	30.51	30.51	0.13	420	0	11894HWL	30.60	30.60	0.05
196	3	11011HW	30.66	30.66	0.67	421	0	11896HWL	30.62	30.62	0.17
197	3	11012HW	30.66	30.66	0.57	422	0	11897HWL	30.62	30.62	0.13
198	**3**	**11232HW**	**30.64**	**30.64**	**5949.26**	423	0	11898HWL	30.59	30.59	0.15
199	3	11233HW	30.59	30.59	1.34	424	0	11900HWL	30.59	30.59	0.09
200	3	11234HW	30.58	30.58	1.96	425	0	11901HWL	30.55	30.55	0.13
201	3	11235HW	30.60	30.60	1.17	426	0	11903HWL	30.56	30.56	0.15

202	3	11236HW	30.60	30.60	0.52	427	3	11904HWL	30.57	30.57	0.22
203	3	11237HW	30.59	30.59	0.31	428	0	11905HWL	30.57	30.57	0.09
204	3	11238HW	30.59	30.59	6.75	429	0	11906HWL	30.46	30.46	0.53
205	3	11239HW	30.54	30.54	5.04	430	0	11906HWL	30.46	30.46	2.78
206	3	11240HW	30.55	30.55	0.98	431	0	11907HWL	30.46	30.46	0.07
207	3	11241HW	30.57	30.57	1.50	432	0	11908RS	30.48	30.48	0.56
208	3	11242HW	30.61	30.61	0.19	433	0	11909HWL	30.47	30.47	0.27
209	3	11243HW	30.61	30.61	0.09	434	0	11910HWL	30.47	30.47	0.12
210	3	11244HW	30.61	30.61	0.15	435	0	11911HWL	30.47	30.47	0.45
211	3	11245HW	30.62	30.62	0.85	436	0	11911HWL	30.47	30.47	1.88
212	3	11246HW	30.62	30.62	0.64	437	0	11912HWL	30.47	30.47	0.15
213	3	11247HW	30.62	30.62	1.09	438	0	11913HWL	30.47	30.47	0.13
214	3	11248HW	30.62	30.62	1.23	439	0	11914HWL	30.47	30.47	0.09
215	3	11250HW	30.62	30.62	0.33	440	0	11915HWL	30.47	30.47	0.04
216	3	11251HW	30.58	30.58	1.07	441	0	11916HWL	30.47	30.47	0.67
217	3	11252HW	30.58	30.58	0.75	442	0	11917HWL	30.46	30.46	0.22
218	3	11253HW	30.58	30.58	0.25	443	3	1514HWL	31.03	31.03	1.90
219	3	11254HW	30.58	30.58	0.15	444	3	1515HWL	31.05	31.05	0.66
220	3	11255HW	30.58	30.58	0.28	445	3	1516HWL	31.06	31.06	0.45
221	3	11256HW	30.57	30.57	0.21	446	3	1517HWL	31.07	31.07	7.77
222	3	11257HW	30.57	30.57	0.19	447	3	1518HWL	30.99	30.99	1.67
223	3	11258HW	30.57	30.57	0.06	448	3	1519HWL	31.01	31.01	0.33
224	3	11259HW	30.58	30.58	0.10	449	**3**	**1520HWL**	**31.01**	**31.01**	**24.23**
225	3	11260HW	30.57	30.57	2.11	450	3	1572HWL	30.95	30.95	2.76

HWL= High Altitude Wetland
RS= River Section
SG= Supra Glacier lakes

Based on LISS-IV satellite data, a total of 2292 lakes/wetlands were mapped during 2023 in comparison to 1953 lakes/wetlands mapped in 2022, 1632 lakes/wetlands mapped in 2021 and to 1359 lakes/high mapped in 2020. Further analysis reveals that 368 lakes mapped in Spiti basin out of 1953 lakes/high altitude wetlands reflecting reduction of 3% in comparison to 2021(379). The analysis further reveals that out of 2292 lakes/wetlands, 470 lakes/wetlands fall in Spiti basin, 487 from Lower Satluj basin and 1335 that from Upper Satluj basin. Further analysis reveals that 470 lakes/wetlands from Spiti basin, 457 lakes / high altitude wetlands delineated were the small one with area less 5ha in comparison to 362 (2022), 366 (2021) to 212 (2020), 9 lakes/wetlands are within the areal range of 5-10 ha in comparison to 5(2022), 10 (2021) and 8 (2020). As far as the big lakes with area >10ha are concerned, only 4 lakes (2023) could be mapped in comparison to 1(2022), 3(2021) and 5(2020) (Fig: 9.10 &9.13).

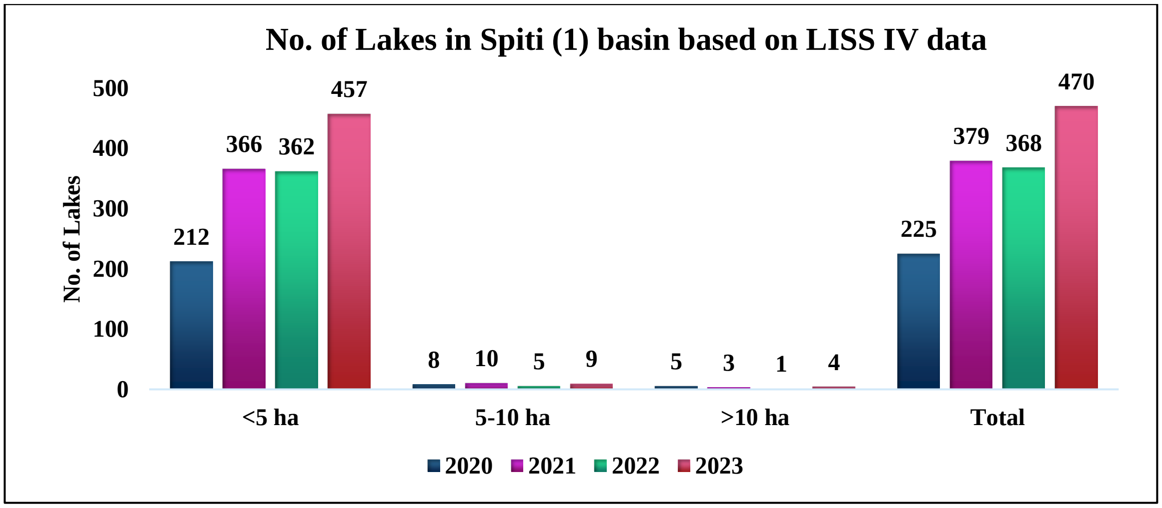


Fig. 9.10: No. of lakes in Spiti basin (1) based on LISS-IV

Likewise, the 487 lakes/wetlands mapped in Lower Saltuj indicates an enhancement of 94% w.r.t. 250 lakes in 2022. Out of 487 lakes, 482 with area less than 5ha were also enhanced w.r.t. 2022(245), 2021(526) and 2020(539), respectively, whereas the lakes within the areal range 5-10 ha varies from 3(2022), 3 (2021) and 1(2020) (Fig: 9.11). In Upper Satluj basin, 1335 lakes mapped in 2023 shows an enhancement of 0.07 % only with that of 2022 (1334) in case of total number of lakes in Upper Satluj basin. Further out of 1335 lakes/wetlands mapped in 2023 comprises of 1253 lakes/wetlands as small one with area <5ha, 39 with area between 5-10ha and 43 with area >10ha respectively (Fig: 9.12 & 9.13).

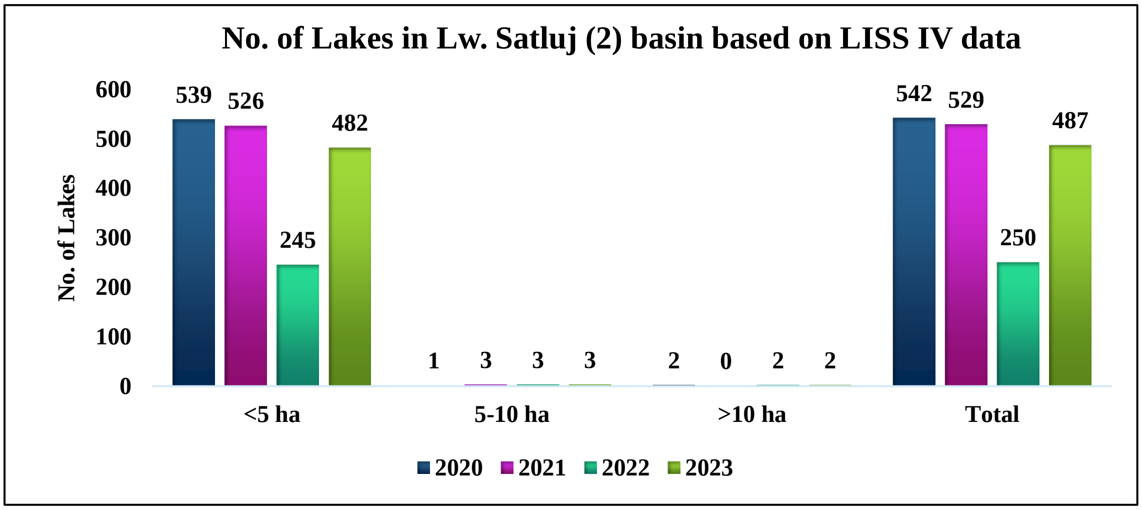


Fig. 9.11: No. of lakes in Lower Satluj basin (2) based on LISS-IV Data

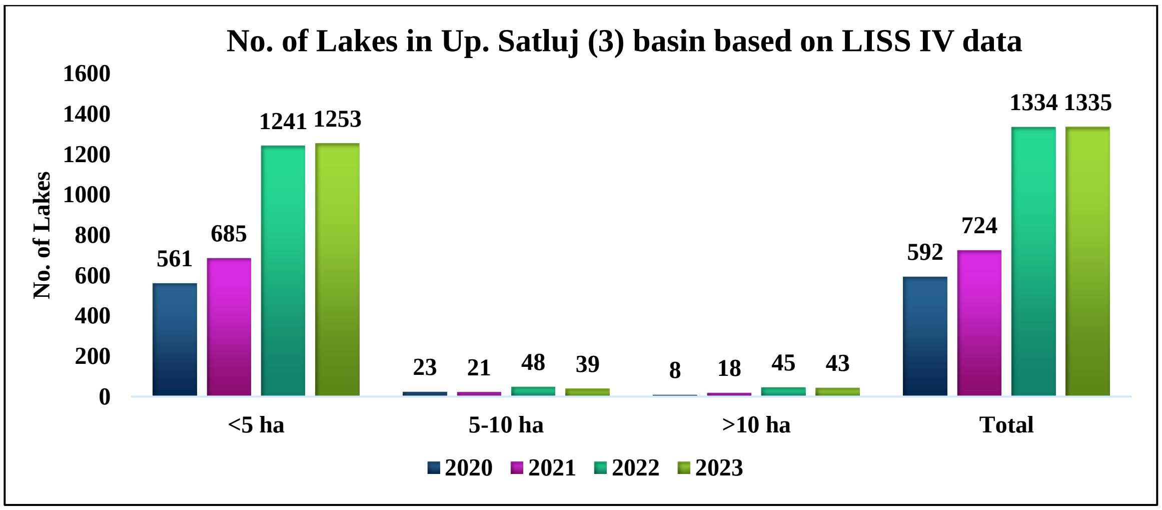


Fig. 9.12: No. of lakes in Upper Satluj basin (3) based on LISS-IV Data

Further analysis of the data reveals that out of 2292 lakes/wetlands delineated, 2192 lakes /wetlands are small one with area less than 5ha in comparison to 1849 of 2022, 51 are within aerial range of 5-10 ha in comparison to 56 (2022) and 49 are the big one with area more than 10 ha in comparison to 48(2022). In other words, we can say that based on the LISS IV data, majority of the lakes /wetlands i.e., 2192 (95%) were the small one with area less than 5ha, 51 (2%) were within the areal range of 5-10ha and 49 (2%) were the big one with area more than 10 ha**.** Further, out of these 2292 lakes/wetlands, 449 lakes have been classified as high-altitude wetlands comprising maximum number of them from small category with area less than 5 ha mainly from the Upper Satluj basin and the remaining 1743 as from the glacial origin (Fig.9.14).

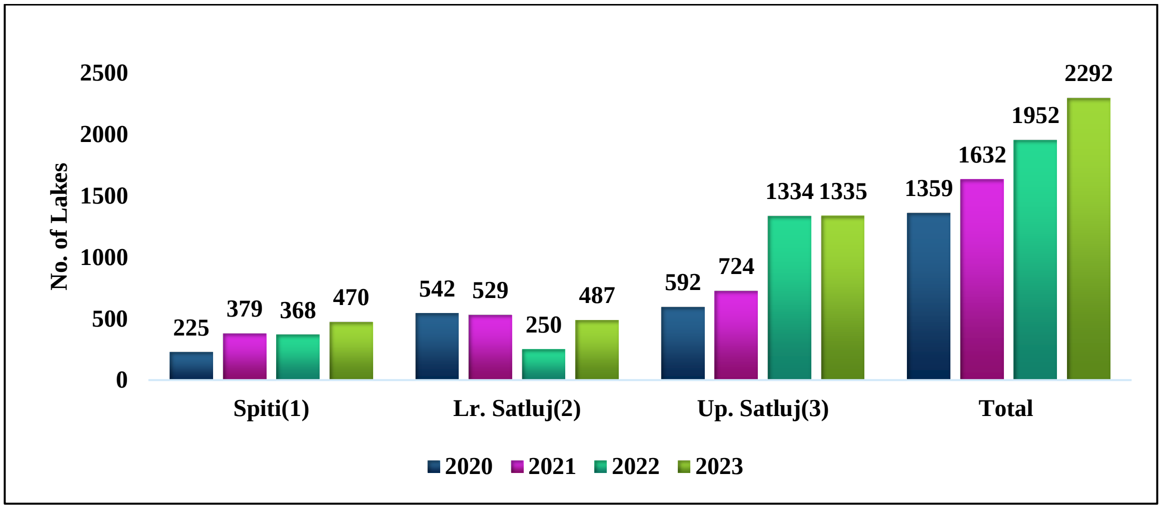


Fig. 9.13: No. of lakes in Satluj Basin based on LISS IV Data (2020- 2023)

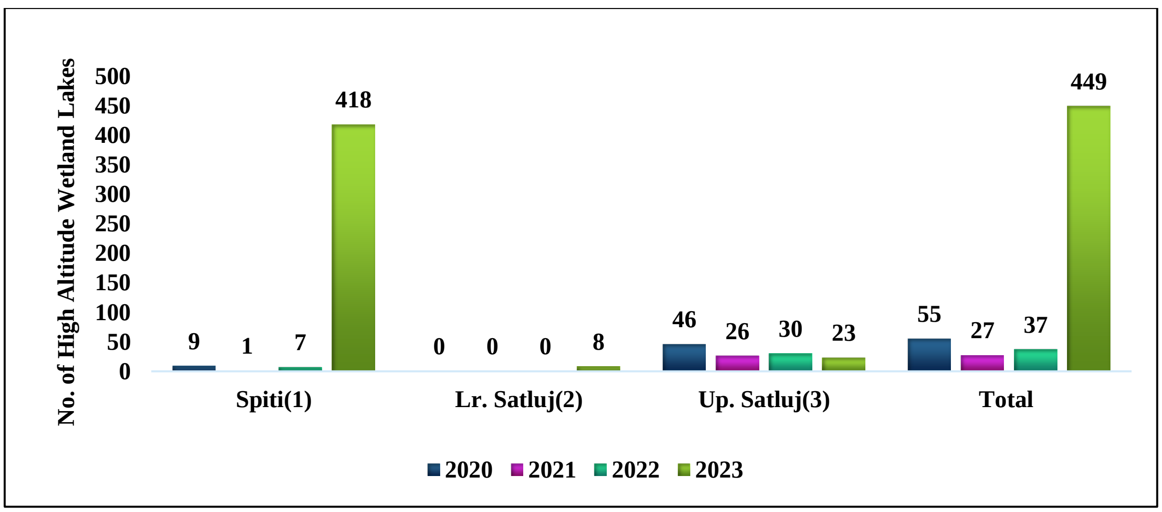


Fig. 9.14: No. of high-altitude wetland lakes in Satluj Basin based on LISS IV data (2020-2023)

The comparative analysis for the lakes mapped during 2023 further reveals that a slight enhancement to the tune of about 0.07 % (1) in the total number of lakes/wetlands was observed in the Upper Satluj basin in comparison to the lakes mapped in 2022 lakes. Likewise, a 94% enhancement in case of Lower Satluj basin i.e., from 250(2022) to

487(2023) and about 27% enhancement in case of Spiti basin i.e., 368(20) to 470(2023). As far as the bigger lakes/wetlands with area more than 10ha were concerned, an increase of 1 lake /wetlands i.e., 49(2023) in comparison to 48 lakes (2022) could be observed reflecting a total increase of about 2% in the bigger lakes during this period (Fig: 9.16). Fig. 9.17 to Fig. 9.26 are some of the clippings of the lake formations as from LISS IV satellite data in different sub basins of the study area.

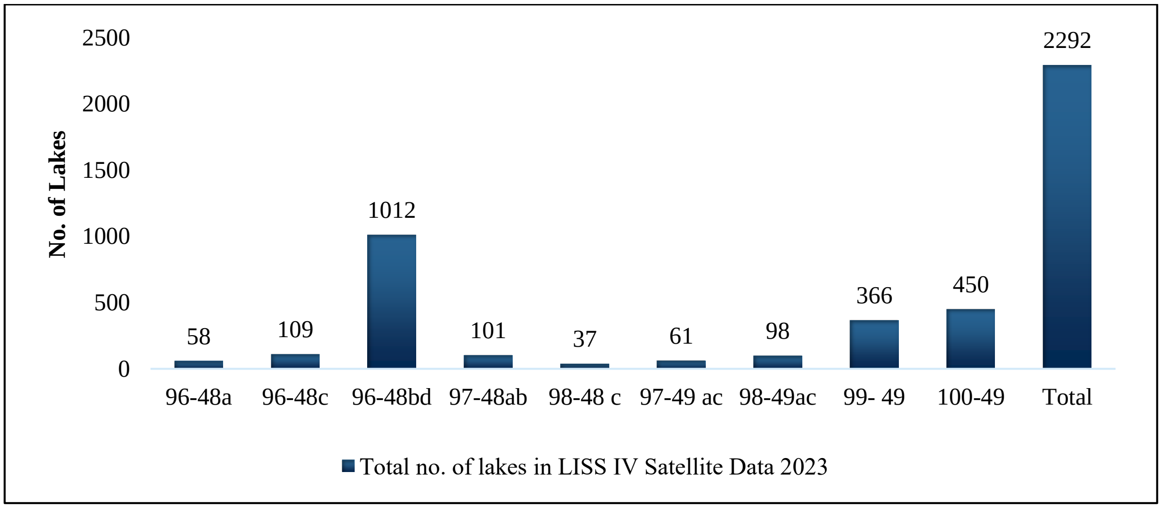


Fig. 9.15: Total no. of lakes in LISS IV Data 2023

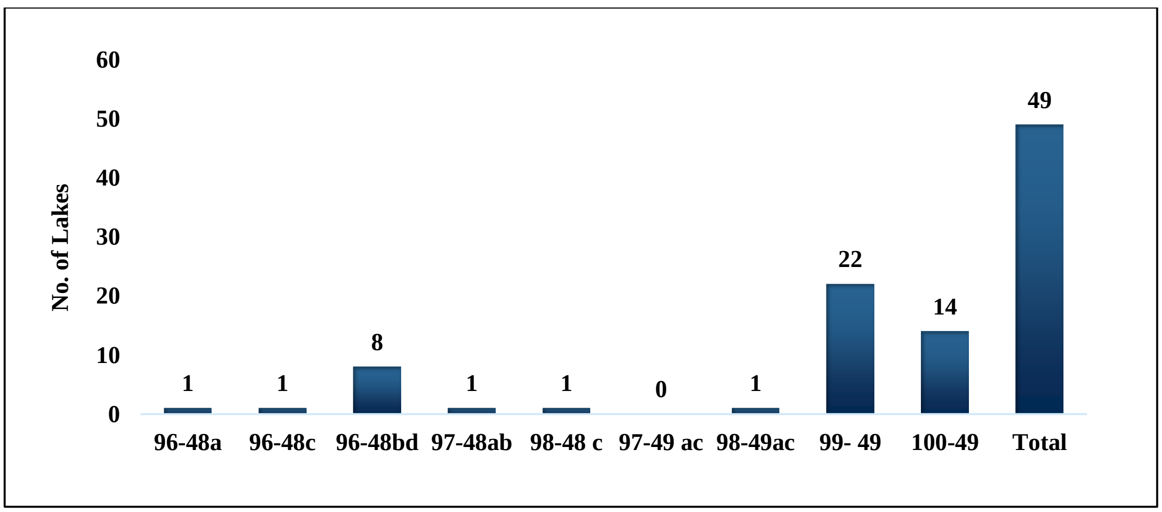
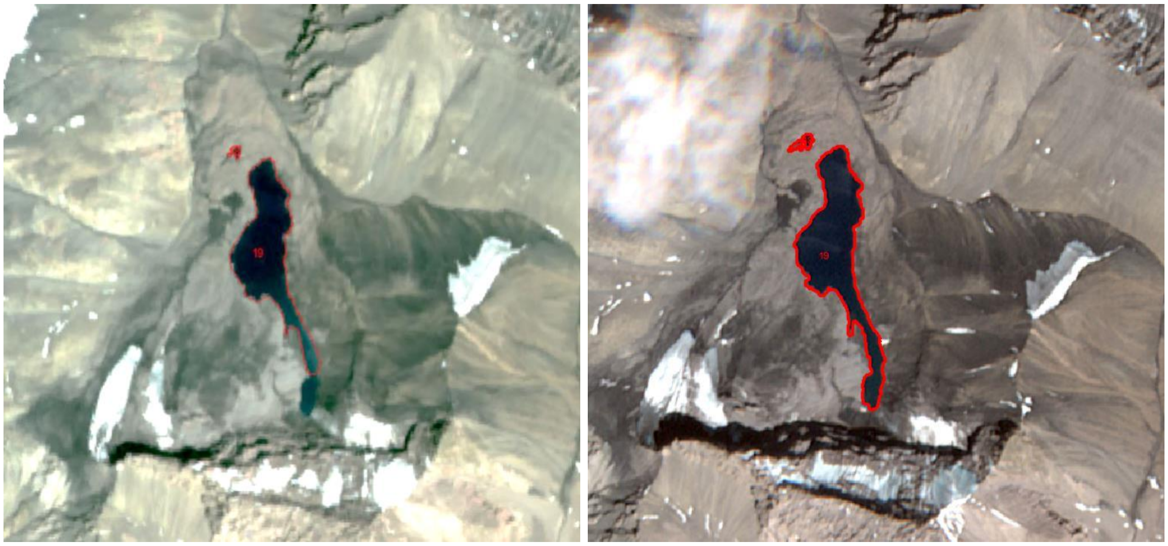


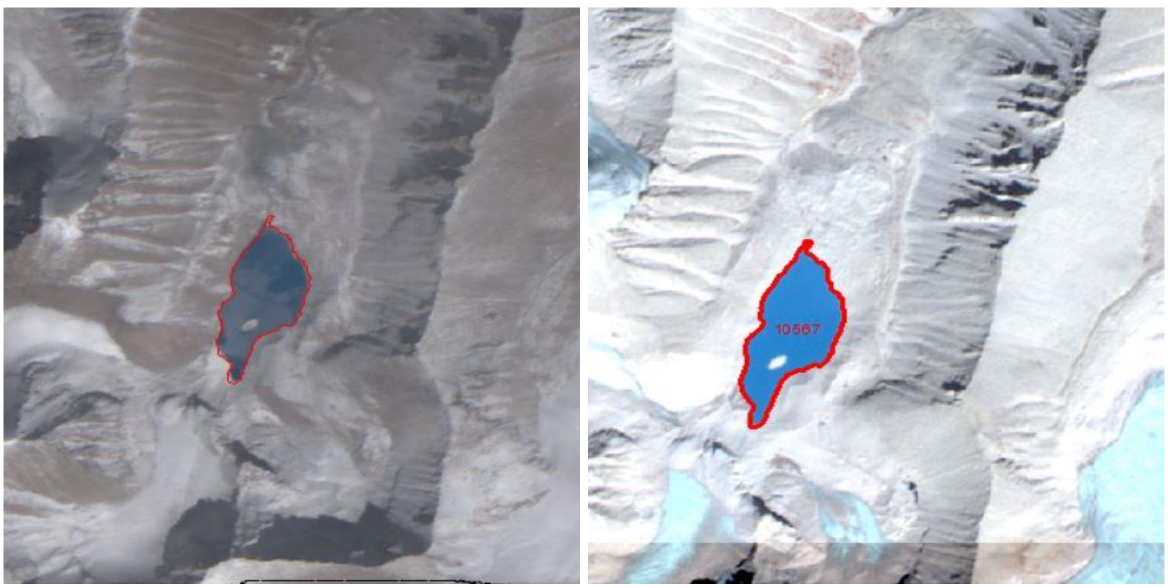
Fig. 9.16: No. of Lakes > 10 ha LISS IV Data 2023

9.2 SATELLITE VIEW OF LAKES IN SATLUJ BASIN (LISS IV)



Area: 12.18 Ha (2022) Area: 13.60 Ha (2023)

Fig. 9.17: Lake Id 19, L4, 96 48 (Spiti Basin)



Area: 16.31 Ha (2022) Area: 16.62 Ha (2023)

Fig. 9.18: Lake Id: 10567, Pro Glacial Lake in Spiti basin

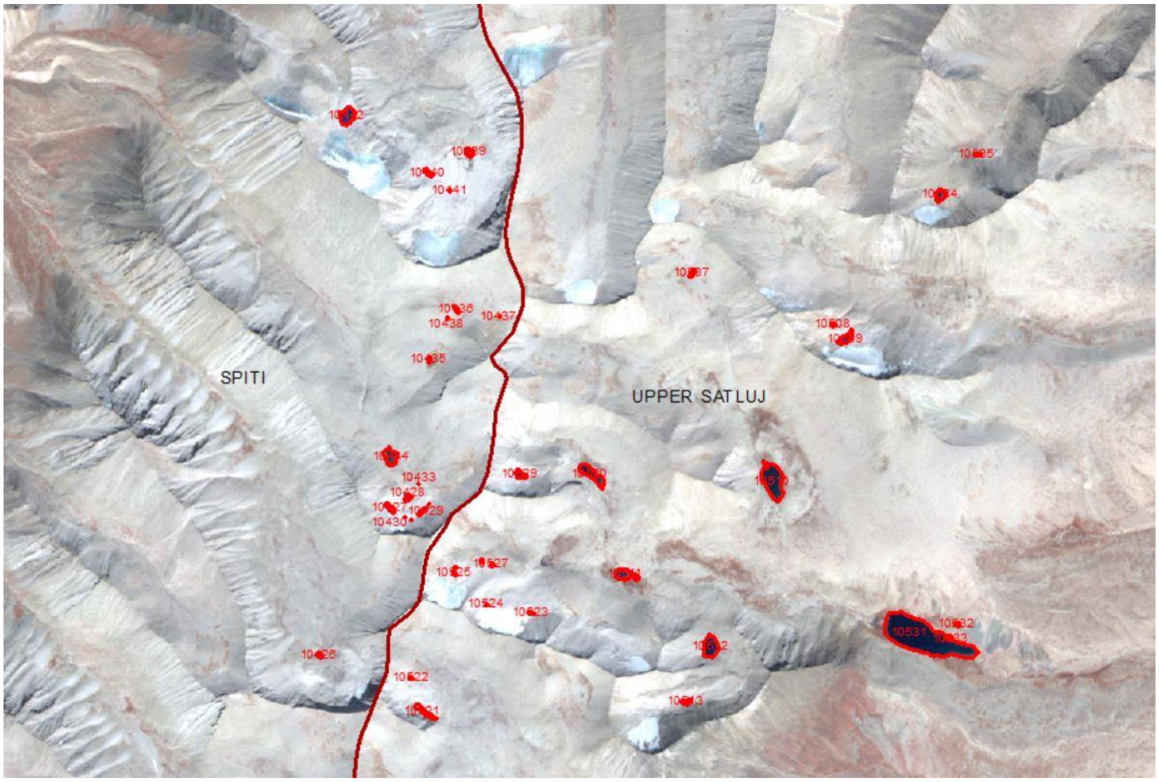


Fig. 9.19: Lakes in Spiti basin and Upper Satluj Basin

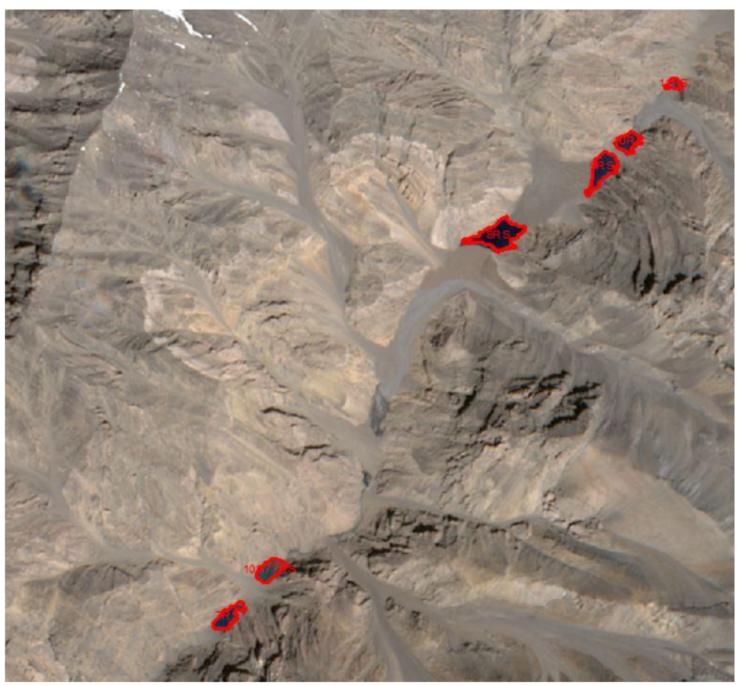


Fig. 9.20: Formation of lakes in River section- Spiti basin

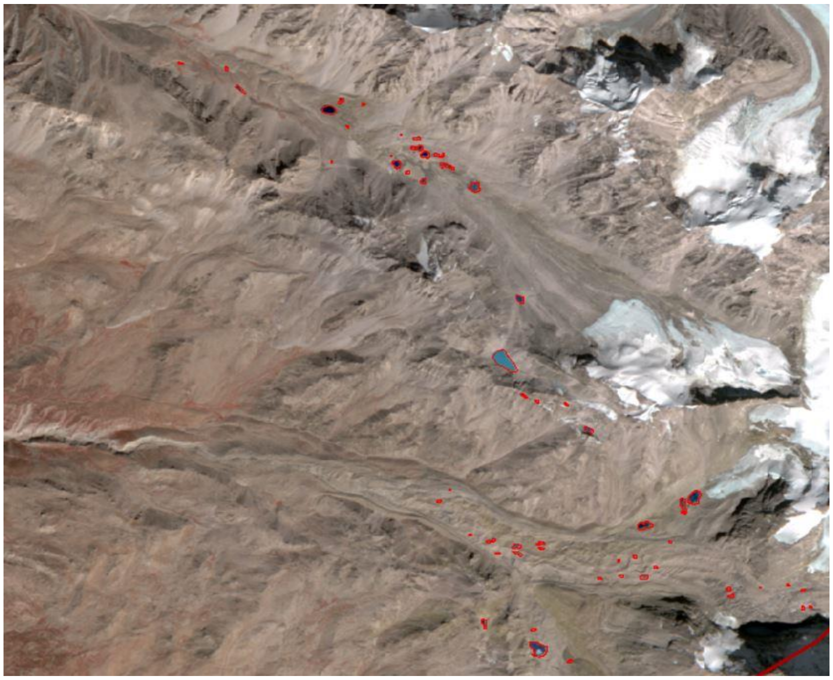


Fig. 9.21: Supra Glacial Lakes in Spiti basin

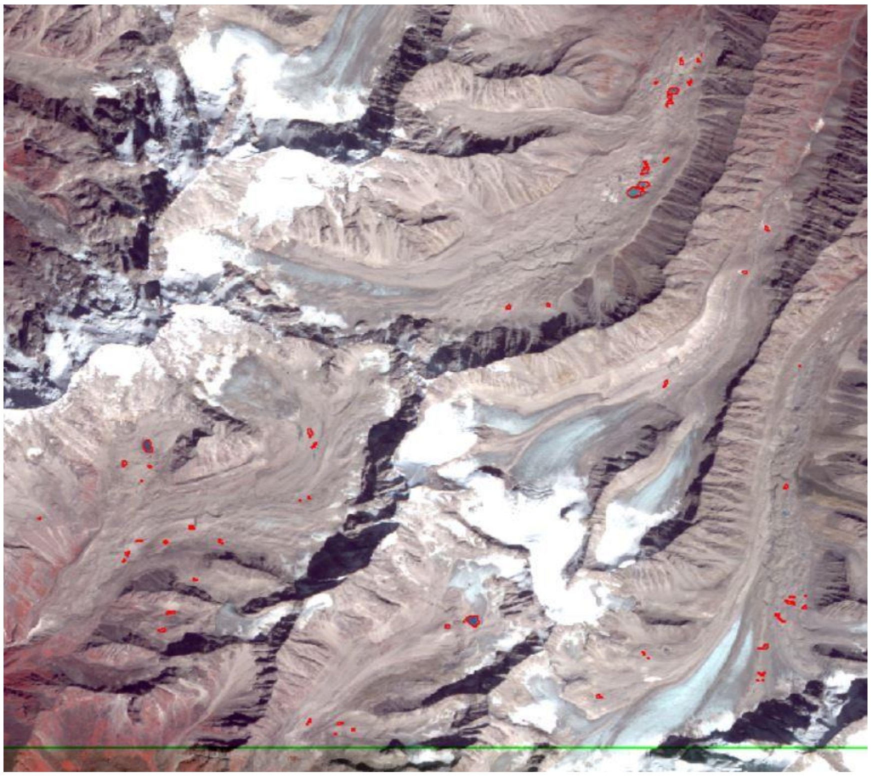


Fig. 9.22: Supra Glacial Lakes in Lower Satluj basin

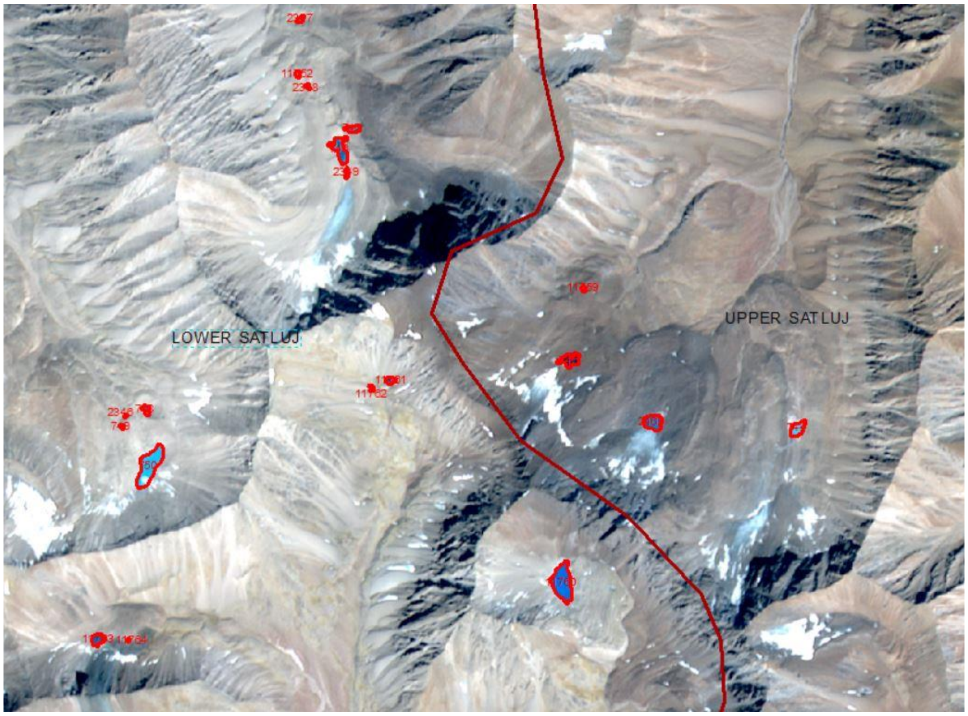


Fig. 9.23: No. of Lakes in Lower and Upper Satluj Basin

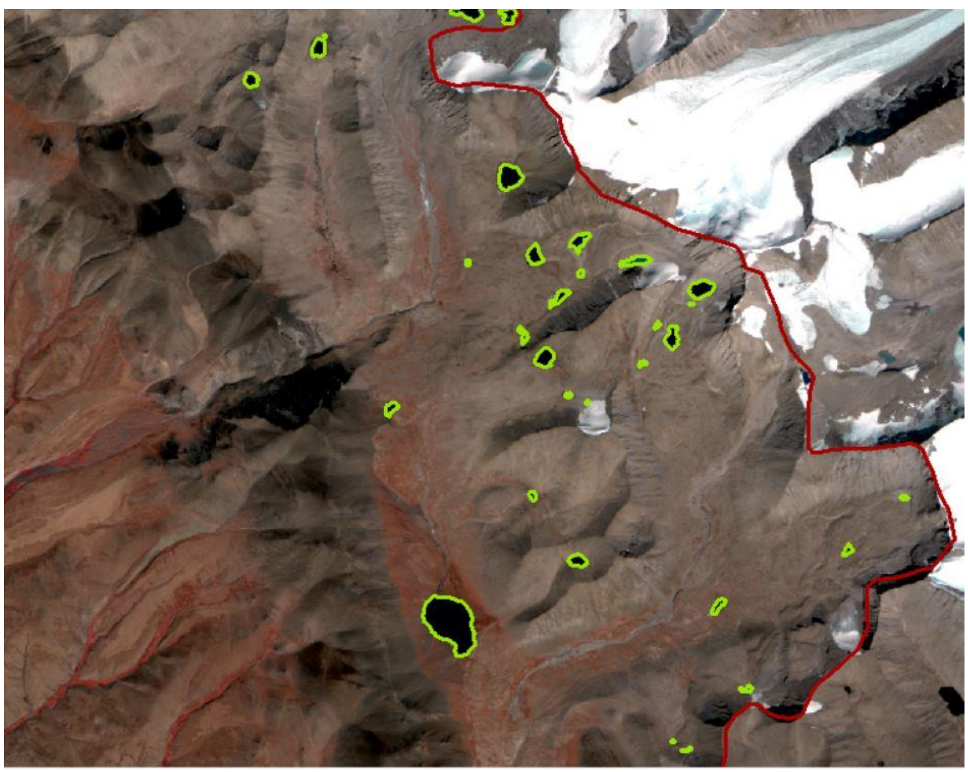


Fig. 9.24: No. of Lakes in Upper Satluj Basin

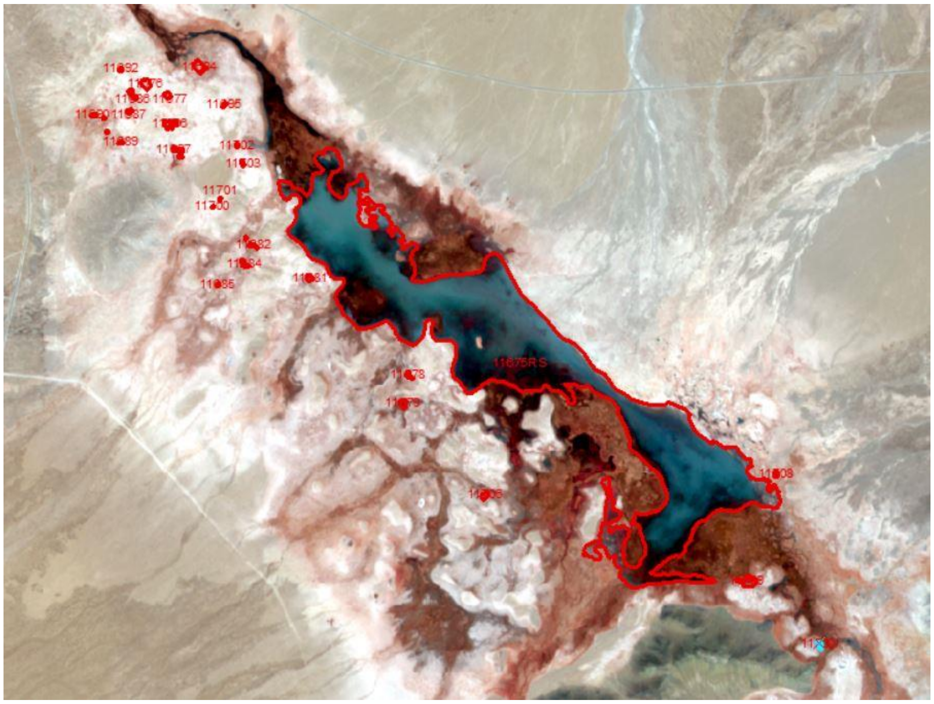


Fig. 9.25: Formation of lakes in River section along the upper catchment of Satluj, Upper Satluj Basin

Fig. 9.26: Formation of lakes in River section along the upper catchment of Satluj, Upper Satluj Basin

10. CONCLUSION

- The application of space data in the field of natural resources mapping, flood protection, landuse/landcover studies, natural hazards and snow cover studies is gaining importance day by day with the modernization of the technology in India. Since this technology helps in acquiring the synoptic coverage of any desired area, it can be used effectively for planning and development. The use of this technology attains significant contribution when the area under investigation in inaccessible and it is not possible to carry out investigations using any conventional methods as in the present case, the study area mainly confines to the Higher Himalayan Regions of the State and the adjoining Trans Himalayan Region in the Tibetan Plateau.
- Scientific insight gained from the analysis of multi spectral satellite images suggests that spatial extent of majority of glaciers is changing very fast leading to the formation of moraine dammed lakes. Formation of such lakes is posing potential threat to the infrastructure and human life thriving in the downstream areas of many drainage systems of the Himachal Pradesh State. Various studies carried out on this vital issue of climate change reveals that there is an alarming increase in numbers and size of the lakes observed over a period of time making vulnerable towards the potential risks of lakes outburst.
- The present study entitled '**Monitoring of Glacial lakes/Water Bodies in Satluj Catchment using space data for 2023** has been carried out using visual Interpretation techniques using space comprising the total catchment area of the Satluj River Basin right from its origin Mansarover Lake in the Tibetan Himalayan Region up to Jhakri in Shimla district of Himachal Pradesh and the study is being carried out as part of Disaster Preparedness Plan of Satluj Jal Vidyut Nigam Ltd. (SJVNL) Shimla since 2009.
- Monitoring has been carried out using IRS RS2 & RS2A AWIFS, LISS III and LISS IV satellite data products having spatial resolution of 56, 23.5 and 5.8 meters. The studies are mainly carried out during the ablation season from April to November reflecting a detailed inventory with high resolution data product using IRS RS2 & RS2A-LISS III and LISS IV sensors and Sentinel data products.

- The Parechhu Lake which is a Landslide Induced Lake (LLOFs) formed within a geomorphic depression along the Parechhu River course in the Tibetan catchment of the Trans Himalayan region has a vast damage history in Himachal Pradesh way back in 2005. Since then, this lake is being monitored regularly using high resolution LISS 3 and LISS 4 satellite data products from April to September during the ablation period and it's up to date information has been given to the concerned agencies such as the State Disaster Management Authority (SDMA), Govt. of Himachal Pradesh, and the SJVNL through online mode. However, the observations made during the year has also been complied and been incorporated in the present technical report. In 2023, not much information could be derived due to data limitations as a result only one scene for August could be investigated. Based on the findings, there does not seem any threat from the lake but needs to be monitored regularly in order to avoid any eventuality arising out of this as per the past. However, on 04 August 2023, the accumulated water in the lake depression could be seen along the periphery of the depression and extending downstream up to the point where landslide seems to have caused slight blockade of the river course i.e., about 727.26 mts. from the lower point of the lake depression. Slight accumulation could also be seen along the braded channels in the upper part along with a small patch on the frontal part of the depression. Based on the tonal difference in the river flow, near the landslide 1, the slide seems to have caused a slight blockade in the river course could be seen resulting to have the accumulation of the water along the stream that extends upwards all along the peripheral side in the frontal portion of the lake depression. The effects of the landslide number 2 on the upper part along the Parechhu River could also be seen reflecting some accumulation along the river course.
- During the 2023, the mapping and monitoring of glacial lakes was carried out using AWIFS, LISS III, Landsat 8, LISS IV and Sentinel satellite data. A total of 22 AWIFS data products were selected based on their quality and cloud /snow cover for the period April to November and were procured form NRSC Hyderabad and have been used in the analysis of the moraine dammed glacial lakes (GLOFs) and the high-altitude wetlands in the catchment of the Satluj River from its origin i.e., Mansarover

Lake in the Tibetan Himalayan Region up to Jhakri i.e., the project site. Besides this, the LISS III (33) and LISS IV (33) satellite data products during the period July to September /October were used for the delineation of glacial lakes/wetlands in the study area. Based on the analysis from different sets of data, single vector layer has been generated for each month from April to November for AWIFS and likewise for the LISS III & LISS IV data analysis.

- During April 2023, only 01 AWIFS data product could be procured reflecting the complete coverage of the study area but the not much information could be derived as most of its area was under the impact of seasonal snow cover. Based on the results obtained for the month of April 2023, a total of 42 lakes/wetland were delineated with 03 lakes/wetlands from the Spiti, 22 from Lower Satluj and 37 from Upper Satluj basin respectively comprising 11 lakes/wetlands as the small one with area less than 5ha, 11 with area between 5-10 ha and 20 as the big one with area >10ha which includes predominantly the high-altitude wetlands.
- During May 2023 only two AWiFS data products were available with partial coverage only as a result of which not much information could be derived due to data coverage and the impact of snow cover. From the analysis only 38 lakes/wetlands comprising 11 from Spiti, 8 from Lower Satluj and 19 from Upper Satluj basin respectively.
- During June 2023, two data products were procured having partial coverage with some increase in their exposed area. Based on the satellite data interpretation, a total 59 lakes/wetlands were mapped out comprising 17 from Spiti Sub basin, 4 from lower Satluj sub basin and 38 from Upper Satluj sub basin. Further analysis of these 59 lakes/wetlands suggests that 24 are small one with area <5ha, 14 with the aerial range 5-10ha and 21 are the big one with area >10ha and out of 59 lakes 10 are the high-altitude wetlands.
- During July 2023, no information could be derived due to non-availability of cloud free data coverage from AWiFS sensor as this period also coincides with the monsoon season in the Himalayan region resulting to have a major limitation in procuring good quality cloud free data coverage.

- During August 2023, 03 data products were available out of 02 were having partial coverage and one with full coverage but was under the impact of cloud cover, as a result it has become possible to delineate a total of 412 lakes/wetlands comprising 55 from Spiti, 58 from Lower Satluj and 299 from Upper Satluj sub basin in comparison to 350 lakes as mapped in 2022. Further analysis of 412 lakes/wetlands reveals that 229 lakes/wetlands were such which have the area less than 5ha, 103 were within the areal range of 5-10 ha and 80 lakes/wetlands were the big one with area more than 10ha. Further classification of 412 lakes/wetlands suggests that 36 have been identified as the high-altitude wetlands in the study area.
- During September 2023, five data products for 2nd, 4th,12th 14th and 26th September 2023 could be procured out of which 03 images were with partial coverage and 02 were with full coverage with some cloud interference. Based on the analysis of the data, 466 lakes/wetlands in comparison to 414 of 2022 were delineated comprising 67 from Spiti, 58 from Lower Satluj and 341 from Upper Satluj basin respectively. Further classification of these 466 lakes/wetlands based on their areal distribution suggest that 270 lakes/wetlands were having area less than 5 ha, 113 within areal range 5-10 ha and 83were big one with area more than 10 ha. Out of 466 lakes, 39 lakes have been classified as high latitude wetland comprising 11 wetlands having area less than 5 ha, 13 are within the areal range of 5-10 ha and 15 having area more than10ha and all these high-altitude wetlands forms part of the Upper Satluj basin, whereas the remaining from the glacial origin.
- 466 lakes/wetland when seen temporally w.r.t. 2022 data, 438 lakes out of 466 lakes were compared for their temporal variation and out of which 280 lakes/wetlands have shown an increasing trend in their water spread, whereas 158 lakes/wetlands shown reducing trend in their water spread with reference to 2022 data. As far as the contribution of each basin is concerned, Spiti basin is characterized by 67 lakes/wetlands, Lower Satluj by 58 and Upper Satluj basin by 341 lakes/wetlands reflecting that maximum (73%) of the total (466) forms part of Upper Satluj basin, 12% from Lower Satluj and 14% from the Spiti basin during the month of September.

- The temporal analysis of the results obtained for maximum number of lakes as derived in September reveals that the Spiti basin is characterized by an increase of 09 lakes as mapped in 2023(67) in comparison to 58 of 2022 comprising 45 lakes with area less 5ha, 16 lakes with area between 5-10ha and 6 lakes with more than 10ha, or in other words we can say that an enhancement of about (15%) could be seen in the Spiti basin as a whole between 2022 and 2023. Likewise, the Lower Satluj basin is characterized by a reduction of about 2% w.r.t 2022 i.e., the number of lakes varies from 59(2022) to 58(2023) comprising 44 lakes having area less than 5ha, 09 lakes within the areal range of 5-10ha and 05 lakes having area more than 10ha. Similarly in Upper Satluj basin, an increase of about 15% w.r.t 2022 could be seen in the total number of lakes mapped as the number increased from 297 (2022) to 341 (2023) comprising 181 lakes with area <5ha, 88 lakes with area between 5-10ha and 72 lakes with area >10ha.
- Thus, based on the results obtained from AWiFS data for 2023, we can say about 73% of the total lakes falls in the Upper Satluj basin, 12% from the Lower Satluj basin and about 14% from the Spiti basin. Further comparative analysis of the bigger lakes with area>10ha reflects that 9% enhancement could be seen in total number of lakes w.r.t 2022 and total number of lakes falling in this category varies 31(2019) to 62 (2020) to 66(2021) to 76(2022) to 83(2023) out of which 15 are the high-altitude wetlands forming part of the Upper Satluj basin. Further it is found that in Spiti basin, the number of lakes with area >10ha varies from 1 (2019) to 7 (2020) to 7(2021) to 7(2022) to 6(2023), in Lower Satluj basin the number of such lakes varies from 0 (2019) to 2 (2020) to 6(2021), 6(2022) to 5(2023) whereas in Upper Satluj basin the number of such lakes varies from 30 (2019) to 53 (2020) to 53(2021) to 63(2022) to 72(2023).
- When the total number of lakes based on AWiFS data is seen w.r.t. 2007(196) as the base line data, it is found that there has been a gradual increase in their number with some abnormalities in the beginning, whereas a gradual increasing trend could be seen from 2012 onwards and the number varies from 128(2012) to 130 (2013) to 192(2014) to 241(2015) to 280(2016) to 280(2017) to 273(2018) to 229(2019) to

361(2020) to 414(2021) to 414(2022) and 466(2023) reflecting an enhancement of about 264% in terms of the total number of lakes in 2023 which includes lakes from the glacial origin as well as the high altitude wetlands with reference to the base line data of 2012(128) and about 137% w.r.t that of 2007(196). Out of 466 lakes mapped in 2023, 39 are the high-altitude wetlands from Satluj basin and the remaining lakes are from the glacial origin. Further these 39 wetlands when seen based on their areal size, it is found that 11 wetlands are of small dimensions i.e., less than 5ha, 13 are of the area between 5-10ha and 15 are of the area more than 10 ha respectively.

- Although September is considered to be the end of the ablation season, but sometimes due to late winter onset and the delay in the snowfall, the area remains exposed even in the month of October and even November also. Thus, considering the AWIFS data availability in October and November, satellite data was procured and analysed for delineation of various lakes/wetlands in the study area.
- In the month of October 2023 from the analysis of 03 AWiFS products, a total of 417 lakes/wetlands were mapped, comprising 54 from the Spiti basin, 43 from the Lower Satluj, and 320 from the Upper Satluj basin. Further out of 417 lakes, 243are with area less than 5 ha comprising 38 in the Spiti, 32 in the Lower Satluj, and 117 in the Upper Satluj basin. Further, 95 lakes were such that they fall within the area range of 5–10 ha, comprising 11 from the Spiti, 8 from the Lower Satluj, and 76 from the Upper Satluj basin. Similarly, 79 lakes with an area greater than 10 ha were classified as big lakes, with 5 from Spiti, 3 from Lower Satluj and 71 from the Upper Satluj basin.
- During November 2022 from the analysis of 02 AWiFS most of the catchment area, only 36 lakes could be mapped due to the impact of fresh snow cover. Out of these 36 lakes, 16 were in the Spiti Sub-basin, 3 in the Lower Satluj Sub basin, and 17 in the Upper Satluj sub-basin respectively. In addition, out of 36 lakes mapped 11 had an area of less than 5 ha, 9 had an area between 5 and 10 ha, and 16 had an area greater than 10 ha. Based on their source, it was found that 9 lakes out of 36 were mostly high-altitude wetlands, with 1 having an area of less than 5 ha and 8 having an area of more than 10 ha.

- Along the course of main Satluj River and Spiti River, few isolated pockets have also been observed which shows accumulated water in the upper catchment of the Tibetan Himalayan Region. Thus, the lakes/water bodies coded with abbreviation *RS* with their ids are some of the locations where accumulated water could be seen and these are the permanent features which needs regular monitoring in order to assess any temporal change in their behaviour.
- As a whole the analysis of AWIFS data reveals the presence of total maximum number of lakes that could be mapped during 2023 varies from April (42), May (38), June (59), July (data gap), August (412), September (466), October (417) and November (36) and the variation in the number is mainly by virtue of data quality and its coverage and also the exposed area available for interpretation purpose (Fig.8.3).
- As far as the lakes with area more than 10 ha is concerned, the total no of lakes that could be mapped from 2019 to 2023 onwards for the maximum number of lakes varies from August (260,66,48,80) to September (31,62,15,76,83 (and October (7,71,66,39,79,41) respectively. In general, the number of such lakes (>10 ha) varies over the years as in the lakes with area 2019 (51), 2020 (71), 2021(66) 2022 (76) and 2023(83)**.**
- As far the lakes with area less than 5ha and between 5-10 ha are concerned during 2023, their number keeps on varying and needs monitoring during the next ablations season wherein they may change their status as far as the water spread distribution is concerned as observed in 2023.
- Based on the analysis for the updation of the detailed inventory of the lakes /wetlands using LISS satellite data products having spatial resolution of 23.5 mts. during 2023, total number of lakes /wetlands mapped varies from 562(2019) to 993(2020) to 880(2021) to 995 (2022) to 1048(2023) and the variation is mainly due to the data gap during one or the other year by virtue of the impact of snow and cloud cover as a result of which complete information could not be derived.
- Out of these total 1048 lakes/wetlands mapped in 2023, 900 lakes have been mapped as the small one with area less 5 ha, 89 lakes with area 5-10ha and 59 lakes with area

more than 10ha.Further out of 1048 lakes/wetlands mapped, 66 are mainly the high-altitude wetlands based on their source of origin.

- The comparative analysis based on LISS-III satellite data from 2019-2023 reveals that the total number of lakes varies from 562 (2019) to 993 (2020) to 880 (2021) to 995 (2022) and 1048 (2023) indicating an overall enhancement of 486 lakes with that of 2019 (86%), enhancement of 55 lakes with that of 2020 (5%), enhancement of 168 lakes with that of 2021(19%) and 53 lakes with that of 2022 (5%) respectively. As far as the big lakes with area more than 10ha are concerned, total number of big lakes varies from 51 (2019) to 62 (2020) to 56 (2021) to 62 (2022) and 59 (2023) indicating a fluctuating trend in the lakes/wetlands with area >10ha based on LISS III data analysis.
- The total variation in the number of lakes mapped in Upper Satluj basin based on LISS III data varies from 437 (2019) to 707 (2020) to 588 (2021) to 639 (2022) to 681(2023), in Lower Satluj basin the number varies from 52 (2019) to 89 (2020) to 163 (2021) to 173 (2022) to 182 (2023) and in case of Spiti sub basin it varies from 73 (2019) to 197 (2020) to 129 (2021)to 183 (2022) to 185 (2023) reflecting that Upper Satluj basin shows an enhancement by about 61% (2019-20), about 16% reduction (2020-21) and again rise by 9% (2021-22) and about 6% (2022-23) and the Lower Satluj basin reflects an enhancement by 71% (2019-20) and further enhancement by 83% (2020-21) and 6% (2021-22) and 6% enhancement between 202-23 could be seen. Likewise, the Spiti basin reflects an enhancement of 169% between 2019-20, 34% reduction between 2020-21 followed by an enhancement of the order of 42% between 2021-22 and 1% enhancement between 2022-23 was seen.
- Thus, from the above analysis for LISS III for the period 2023, it is clear that although the maximum number of lakes (about 65%) are formed in the Upper Satluj basin, about 17% in the Lower Satluj basin and about 18% in the Spiti basin of the study area and majority of the lakes (900) delineated in the entire study area during 2023 are small one with area less than 5 ha (about 86%), about 9% are within 5-10 ha (89 lakes/wetlands) and about 5% with area more than 10 ha (59 lakes/wetlands) reflects that the Upper Satluj basin is more susceptible for undergoing climate induced

changes resulting to have higher number of such lakes than the Lower Satluj and Spiti basin along with the permafrost conditions which led to the formation of high altitude wetlands in the adjoining Trans Himalayan Region of the Upper Satluj basin.

- Thus, to summaries based on the results obtained by using AWiFS and LISS III data products, the results obtained using AWiFS data reflects that the total number of lakes delineated during 2023 has increased from 414 (2022) to 466 (2023) reflecting an overall increase of about 13% w.r.t 2022.
- Further as far as basin wise distribution for 2023 is concerned, about 14% (67) lakes/wetlands forms part of the Spiti sub basin, 12% (58) of the Lower Satluj basin and 73% (341) forms part of the Upper Satluj basin respectively reflecting an increase of about 15% in Spiti basin, about 2% reduction in Lower Satluj and 15% increase in the Upper Satluj basin in the formation of total number of lakes in 2023 in comparison to 2022 based on AWIFS data products.
- Further as far as the bigger lakes with area >10 ha from AWiFS data is concerned, about 25% increase could be seen in 2023 (83) in comparison to 2021 (66) and about 9% in comparison to 2022 (76) and majority of the lakes (72) forming part of the Upper Satluj basin, 5 from the Lower Satluj basin and 6 from the Spiti basin. Out of 466 lakes, 39 are the high-altitude wetlands and the remaining lakes were from the glacial origin.
- Likewise, LISS-III data indicates an enhancement of about 5% in terms of the total lakes and about 5% reduction in terms of the bigger lakes in comparison to 2022 in the entire Satluj catchment. Further based on comparative analysis, 6% enhancement in Upper Satluj basin, 5% in Lower Satluj basin and 2% enhancement in Spiti basin could be seen between 2022 & 2023 with maximum number of lakes (about 65%) are being formed in the Upper Satluj basin, about 17% in the Lower Satluj basin and about 18% in the Spiti basin of the study area.
- Further based on the size of the lakes from LISS III, majority of the lakes i.e., 86% (900) are the small one with area less than 5 ha, about 9% are within 5-10 ha (89 lakes/wetlands) and about 5% with area more than 10 ha (59 lakes/wetlands) respectively.

- Classification of the lakes based on their origin suggest that, about 9% (39) of the total maximum lakes mapped during the month of September were the high altitude wetlands out of 466 lakes mapped from AWIFS satellite data and 6% (66) from the LISS III satellite data out of 1048 total lakes mapped .Remaining lakes are the lakes from the glacial origin i.e. either these are formed at or near the glacier snouts known as Moraine Dammed Glacial Lakes or more commonly known as GLOFs or the Supra Glacial lakes i.e. within the glacier body in the ablations zones of the glaciers.
- The high-altitude wetlands in the Upper Satluj basin are mainly formed due to the permafrost which is the common feature in the Tibetan Plateau region resulting into the appearance of such water bodies.
- The lakes /wetlands with ids RS mapped in Spiti and Upper Satluj basin although small except few but needs monitoring in order to avoid any situation that may lead to flash floods in the downstream in case if they burst.
- During the year 2023, using LISS IV (5.8 mts.) inventory of lakes/wetlands was prepared giving more precise information about the catchment wherein it has not become possible to delineate the lakes/wetlands with area less than 23.5mts in the Satluj basin.
- The data which was available and analysed mainly falls within 96-48a, 96-48c, 97-48a, 97-48c, 97-49b, 98-49a, 98-48c, 98-49c, 100-49c path-row for data coverage of LISS IV.
- Based on the above mentioned LISS-IV satellite data, a total of 2292 lakes/high altitude wetlands could be delineated comprising 470 (20%) from Spiti basin i.e., basin 1, 487 (21%) from the Lower Satluj basin i.e., basin 2 and 1335 (58%) from the Upper Satluj basin i.e., basin 3, out of which 449 lakes have been classified as high-altitude wetlands and the remaining 1743 from the glacial origin.
- Further analysis of the data reveals that out of 2292 lakes/wetlands delineated, 2192 were the small one with area less than 5 ha, 51 were within the area range of 5-10 ha and 49 were the one which have the area more than 10ha respectively in other words we can say that (96%) were the small one with area less than 5 ha, (2%) were within

the areal range of 5-10 ha and (about 2%) were the big one with area more than 10 ha.

- The comparative analysis based on three different sets of data from AWIFS, LISS III and LISS IV sensors reflects that in Spiti basin, the number of lakes delineated has been enhanced from 67 with AWIFS sensor to 185 with LISS III to 470 with LISS IV during 2023 in comparison to 58 with AWIFS sensor to 183 with LISS III sensor and further 368 with LISS IV sensor in 2022. Likewise, in Lower Satluj basin, the 58 lakes as delineated from AWIFS sensor has increased to 182 with LISS III to 487 with LISS IV during 2023 in comparison to 59 lakes delineated from AWIFS sensor increased to 173 in LISS III and 250 with LISS IV sensor in 2022. Similarly in Upper Satluj basin 341 lakes as mapped from AWIFS sensor has increased to 681 with LISS III to 1335 with LISS IV during 2023 in comparison to the 297 lakes as delineated from AWiFS sensor has increased to 639 with LISS III and 1334 with LISS IV in 2022 respectively and the variation is mainly due to the data gap in LISS IV which mainly covers the areas falling in Spiti & Upper Satluj basins during 2022. Thus, from the above analysis based on LISS IV sensors, it is inferred that the level of information in each catchment has increased and more detailed information could be derived which would form the base line data for future investigations with higher resolutions satellite data.
- As far as the basin wise susceptibility is concerned, it is observed that based on the distribution of the lakes, the basin 3 i.e., the Upper Satluj basin, the number of lakes is quite high in all the cases either in AWIFS (73%) or LISS III (65%) or LISS IV (58%) followed by Lower Satluj basin, wherein the number varies from AWiFS (12%), LISS III (17%) and LISS IV (21%) and in Spiti basin (approx. 14% ,18% and 20%) and thus basin 3 i.e., Upper Satluj basin seems to be more susceptible as far as moraine dammed lakes/water bodies formation is concerned in the study area.
- Thus, based on three sets of data base from AWIFS, LISS III and LISS IV for the year 2022, having spatial resolution of 56, 23 and 5.8 meters, a complete inventory of the glacial lakes has been prepared in the Satluj catchment fulfilling the objectives as laid down in the National Guidelines for GLOFs issued by National Disaster

Management Authority (NDMA), Govt. of India during the year 2021. Although there are some data gaps in LISS IV data products due to non-availability of cloud freed data, but still information level has been increased illustrating more detailed insight of the catchment, which would further be refined during the next year.

10.1 CONCLUDING REMARKS

The present study Monitoring of Glacial Lakes in Satluj Catchment has been carried out using IRS–RS2, AWIFS, IRS RS2 & RS2A LISS-III and IRS RS2A LISS -IV Satellite data products having spatial resolution of 56mts, 23.5mts and 5.8mts for the year 2023 from April to November. The catchment area in the Satluj River basin was studied from upstream of Jhakri to Mansarover Lake in the Tibetan Himalayan Region in the Trans Himalayan Region from where the Satluj River originates. The study was carried as part of the disaster preparedness plan of Satluj Jal Vidyut Nigam Ltd. (SJVNL) to assess the threat from the Moraine Dammed Glacial Lakes/Water Bodies during the year 2023. This study is being carried out regularly since 2009 during the ablation season (April to October/November) every year.

In the present study, analysis has been carried out in the study area by using 22 AWIFS data products from April to November 2023 and LISS III coverage within the path row 96-48,96-49,97-48,97-49,98-48,98-49,99-49,100-49 using IRSRS2/RS2A comprising 33 LISS-III data products and 96/48a,96/48b, 96/48c, 96/48d, 97/48a, 97/48b, 97/48c, 97/49b, 98/49a, 98/48c, 98/49c, 99/49a, 99/49b, 99/49c, 99/49d, 100-49c using LISS IV data products. During early summer period (April to June) being the start of ablation not much information could be derived as most of the catchment area was under the impact of snow cover as a result the glaciated area was not exposed and very limited information could be obtained. Based on the observations derived from AWiFS data products for the month of April 2023, only 42 lakes/wetland could be delineated. In May 2023, a total of 38 lakes and in June only 59 lakes/wetlands could be derived from AWIFS products.

July to September is generally considered as the ideal period for carrying glaciological studies as most of the area during this period is free from snow cover impacts and thus completely exposed and the glacier features are fully developed as result of which maximum information from the glaciated regimes can be obtained. But as this period also coincides with the monsoon season in the Himalayan region, so procuring good quality cloud free data coverage is a major challenge. During July 2023, only one AWIFS data product could be procured, that too was not of good quality due to cloud cover impacts and as a result no information could be derived during July 2023. From August 2023 AWIFS satellite data, a total of 412 lakes in the entire catchment could be mapped comprising 55 from the Spiti sub basin i.e., Basin 1, 58 from the Lower Satluj sub basin i.e., Basin 2 and 299 from Upper Satluj sub basin i.e., Basin 3 in comparison to the 414 lakes, the maximum number that was observed in 2022 could be delineated. Further out of 412 lakes, 229 lakes were small one with area less than 5 ha, 103 were within the areal range of 5-10 ha and 80 lakes were the big one with area more than 10 ha.

During September 2023, maximum number of lakes from AWIFS data were mapped from four data products for 2nd, 04th, 12th, 14th and 26th September 2023 and based on the analysis 466 lakes were delineated in comparison to 414 of September 2022 indicating an overall increase of 52 lakes during 2023 based on AWiFS data product. Basin wise analysis based on AWIFS data reveals that out of 466 lakes mapped in September 2023, the total number of lakes forming part of Spiti basin were 67 in comparison to 58(2022), 58 from the Lower Satluj basin in comparison to 59 (2022) and 341 forms part of the Upper Satluj basin in comparison to 297 (2022) respectively. However, on analysing the total lakes based on the aerial extent, the total lakes with area more than 10ha has increased from 76 (2022) to 83 (2023), whereas the lakes with aerial range 5-10 ha are 113 in 2023 and <5 ha are 270 (2023) respectively. Out of 466 lakes, 39 lakes have been classified as high latitude wetland comprising 11 wetlands having area less than 5 ha, 13 are within the areal range of 5-10 ha and 15 having area more than10 ha and all these high-altitude wetlands forms part of the Upper Satluj basin, whereas the remaining from the glacial origin. 466 lakes/wetland when seen temporally w.r.t. 2022 data, 438 lakes out of 466 lakes could be compared for their temporal variation and out of which 280 lakes/wetlands have shown an increasing trend in their water spread, whereas 158 lakes/wetlands shown a reducing trend in their water spread with reference to 2022 data. As far as the contribution of each basin is concerned, maximum

(73%) of the total (466) forms part of Upper Satluj basin, 12% from Lower Satluj and 14% from the Spiti basin during the month of September.

When the total number of lakes based on AWiFS data is seen w.r.t. 2007(196) as the base line data , it is found that a there has been a gradual in their number with some abnormalities in the beginning, whereas a gradual increasing trend could be seen from 2012 onwards and the number varies from 128 (2012) to 130 (2013) to 192 (2014) to 241 (2015) to 280 (2016) to 280 (2017) to 273 (2018) to 229 (2019) to 361 (2020) to 414 (2021) to 414 (2022) and 466 (2023) reflecting an enhancement of about 264% in terms of the total number of lakes which includes lakes from the glacial origin as well as the high altitude wetlands with reference to the base line data of 2012(128) and about 137% w.r.t. that of 2007 (196).

Based on the updated inventory of glacial lakes using LISS III satellite data during 2023, total number of lakes /wetlands mapped varies from 562 (2019) to 993 (2020) to 880 (2021) to 995 (2022) to 1048(2023. Out of the total 1048 lakes mapped in 2023, 900 lakes have been mapped as the small one with area less 5 ha, 89 lakes with area 5-10 ha and 59 lakes with area more than 10ha and further out of 1048 lakes mapped, 66 are mainly the high-altitude wetlands based on their source of origin. The comparative analysis based on LISS-III satellite data from 2019-2022 reveals an overall enhancement of 486 lakes with that of 2019 (86%), enhancement of 55 lakes with that of 2020 (5%), enhancement of 168 lakes with that of 2021 (19%) and 53 lakes with that of 2022 (5%) respectively. As far as the big lakes with area more than 10 ha are concerned, total number of big lakes varies from 51 (2019) to 62 (2020) to 56 (2021) to 62 (2022) and 59 (2023) indicating a fluctuating trend. The basin wise temporal variation in the total number of lakes reflects that Upper Satluj basin shows variation from 437 (2019) to 707 (2020) to 588 (2021) to 639 (2022) to 681 (2023), in Lower Satluj basin the number varies from 52 (2019) to 89 (2020) to 163 (2021) to 173 (2022) to 182 (2023) and in case of Spiti sub basin it varies from 73 (2019) to 197 (2020) to 129 (2021)to 183 (2022) to 185 (2023) reflecting that Upper Satluj basin shows an enhancement by about 61% (2019-20), about 16% reduction (2020-21) and again rise by 9% (2021-22) and about 6% (2022-23) and the Lower Satluj basin reflects an enhancement by 71% (2019-20) and further enhancement by 83% (2020-21) and 6% (2021-22) and 6%

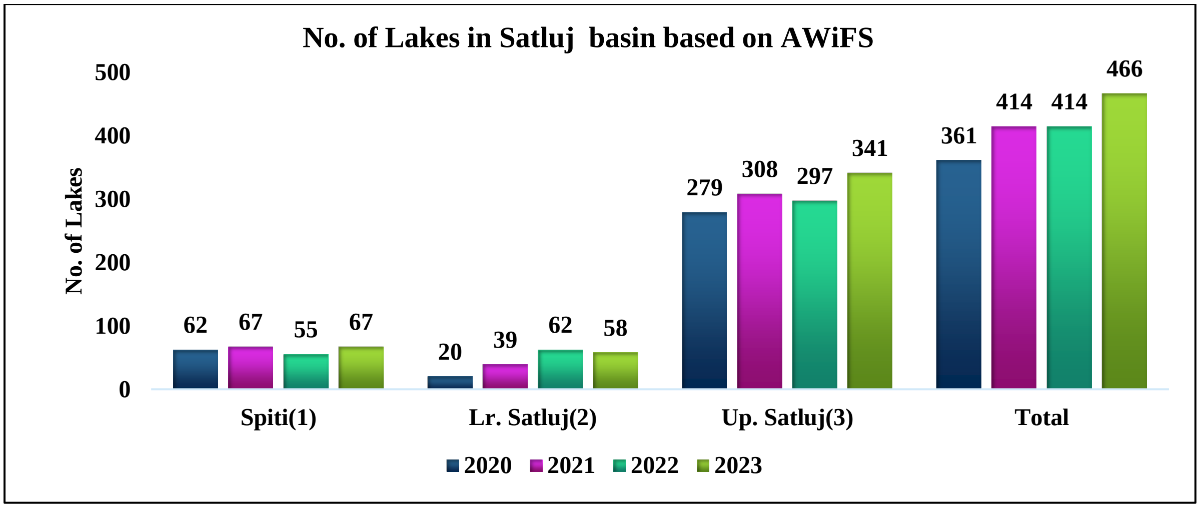
enhancement between 202-23 could be seen. Likewise, the Spiti basin reflects an enhancement of 169% between 2019-20, 34% reduction between 2020-21 followed by an enhancement of the order of 42% between 2021-22 and 1% enhancement between 2022-23 could be seen. From the above analysis, it is clear that the maximum number of lakes (about 65%) are being formed in the Upper Satluj basin , about 17% in the Lower Satluj basin and about 18% in the Spiti basin of the study area and majority of the lakes (86%) are small one with area less than 5ha, about 9 % are within 5-10 ha and about 5% with area more than 10ha reflects that the Upper Satluj basin is more susceptible for undergoing climate induced changes resulting to have higher number of such lakes than the Lower Satluj and Spiti basin long with the permafrost conditions which led to the formation of high altitude wetlands in the adjoining Trans Himalayan Region of the Upper Satluj basin.

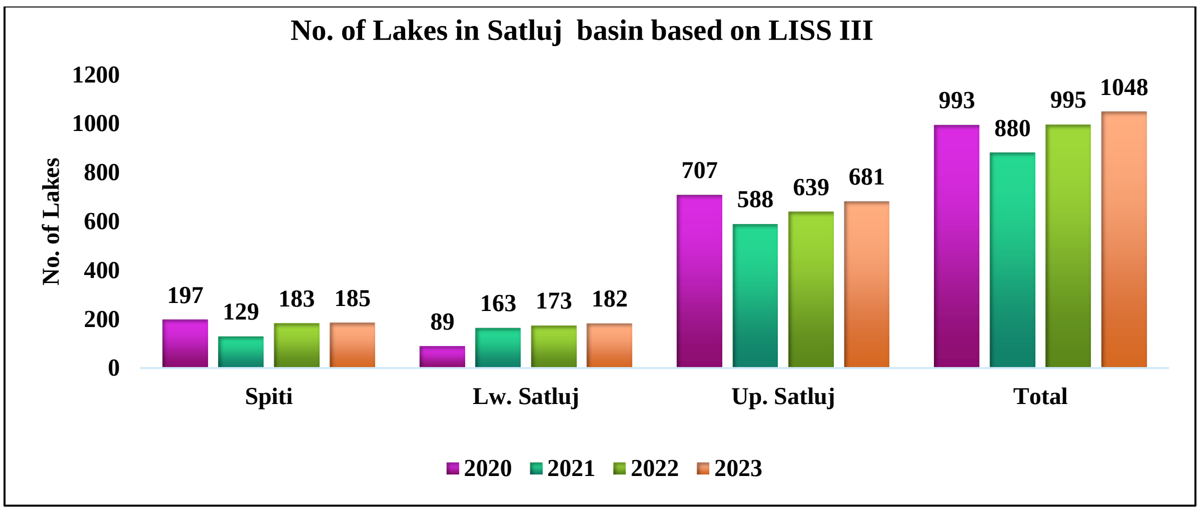
Further analysis of very high-resolution satellite data of LISS IV, a total of 2292 lakes/high altitude wetlands have been mapped in the Satluj catchment in comparison to 1952(2022), 1632 (2021) and 1359(2020). Basin wise distribution of 2292 lakes /wetlands reveals that 470 (20%) lakes are from Spiti basin, 487 (21%) from the Lower Satluj basin and 1335 (58%) from the Upper Satluj basin i.e., basin 3, out of which 449 lakes have been classified as high-altitude wetlands and the remaining 1743 as from the glacial origin. Further out of 2292 lakes/wetlands delineated, 2192 were the small one with area less than 5 ha, 51 were within the area range of 5-10 ha and 49 were the one which have the area more than 10 ha respectively in other words we can say that (95%) were the small one with area less than 5 ha, (2%) were within the areal range of 5-10 ha and (about 2%) were the big one with area more than 10 ha.

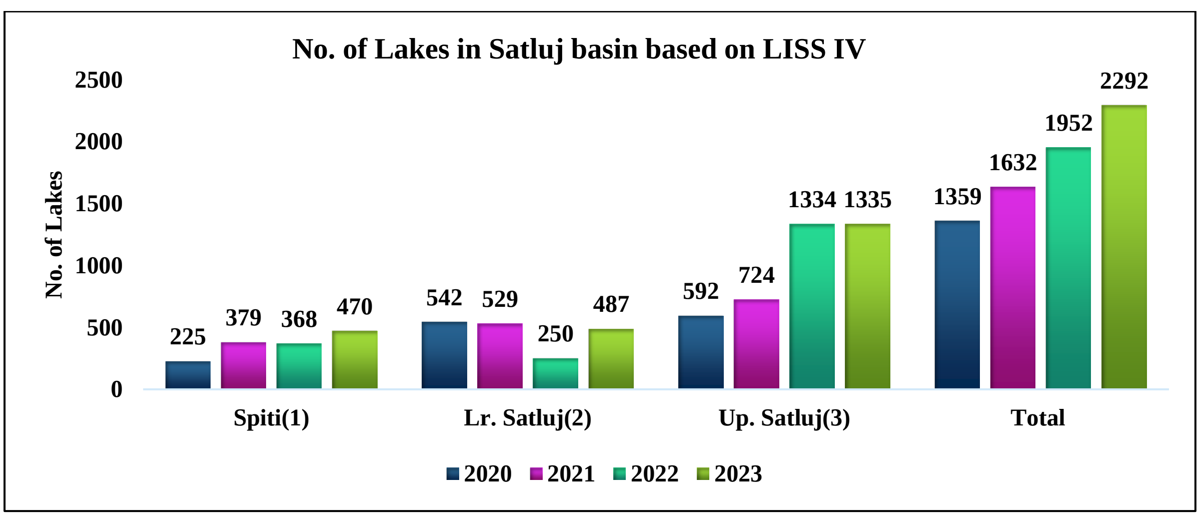
The comparative analysis based on three different sets of data from AWIFS, LISS III and LISS IV sensors reflects that in Spiti basin, the number of lakes delineated has been enhanced from 67 with AWIFS sensor to 185 with LISS III to 470 with LISS IV during 2023 in comparison to 58 with AWIFS sensor to 183 with LISS III sensor and further 368 with LISS IV sensor in 2022. Likewise, in Lower Satluj basin, the 58 lakes as delineated from AWIFS sensor has increased to 182 with LISS III to 487 with LISs IV during 2023 in comparison to 59 lakes delineated from AWIFS sensor increased to 173 in LISS III and 250 with LISS IV sensor in 2022. Similarly, in Upper Satluj basin 341 lakes as mapped from AWIFS sensor has increased to 681 to 1335 with LISS IV during 2023 in comparison to the 297 lakes as delineated from AWiFS sensor has increased to 639 with LISS III and 1334 with LISS IV in 2022 respectively and the variation is mainly due to the data gap in LISS IV which mainly covers the areas falling in Spiti & Upper Satluj basins during 2022. Thus, from the above analysis based on LISS IV sensors, it is inferred that the level of information in each catchment has increased and more detailed information could be seen which would form the base line data for future investigations with higher resolutions satellite data and the percentage increase with different sensors varies from 12.56% (2022-23 with AWiFS sensor, 5.32: with LISS III and 17.35 % with LIISS IV sensor during 2022-23 respectively.

Table 12.1: - Comparative Analysis of 03 Different Sensors

Sr. No.	**Basin Name**	**Sensor**											
		AWiFS (56mts)				**LISS III(23.5mts)**				**LISS IV(5.8mts)**			
		2020	**2021**	**2022**	**2023**	**2020**	**2021**	**2022**	**2023**	**2020**	**2021**	**2022**	**2023**
1	Spiti (1)	62	67	55	67	197	129	183	185	225	379	368	470
2	Lower Satluj (2)	20	39	62	58	89	163	173	182	542	529	250	487
3	Upper Satluj (3)	279	308	297	341	707	588	639	681	592	724	1335	1335
4	Total Satluj Basin	**361**	**414**	**414**	**466**	**993**	**880**	**995**	**1048**	**1359**	**1632**	**1953**	2292


No. of Lakes in Satluj basin based on AWiFS
No. of Lakes
500
400
300
200
100
0
62 67 55 67
20 39 62 58
279 308 297 341
361 414 414 466
Spiti(1)
Lr. Satluj(2)
Up. Satluj(3)
Total
2020 2021 2022 2023


No. of Lakes in Satluj basin based on LISS III
No. of Lakes
1200
1000
800
600
400
200
0
197 129 183 185
89 163 173 182
707 588 639 681
993 880 995 1048
Spiti
Lw. Satluj
Up. Satluj
Total
2020 2021 2022 2023


No. of Lakes in Satluj basin based on LISS IV
No. of Lakes
2500
2000
1500
1000
500
0
225 379 368 470
542 529 250 487
592 724 1334 1335
1359 1632 1952 2292
Spiti(1)
Lr. Satluj(2)
Up. Satluj(3)
Total
2020 2021 2022 2023

The Parechhu Lake was formed in 2004 in the Trans Himalayan Region of the Tibetan Plateau by virtue of damming of the river course due to landslide and has the potential threat for the downstream areas in the Satluj catchment since then. As far as the origin of this lake is concerned, this is a simple geomorphic depression close to the Sumdo - Korik fault, a prominent active Geological Structure that might have activated the landslides in the region as a result of which lake was formed due to damming of the river course and the rise in water column caused the filling up of the geomorphic depression in the upstream side. Since then, this lake is being monitored regularly using space data. During 2023, the lake was monitored and does not show any major change in its water spread and seems to be stable based on the observations made which have been reported to SJVNL as well as to the Government during 2023. But the presence of landslide on the upstream side of the lake depression and another one on the downstream side on the right bank is another likely threat for its damming again and thus needs to be monitored in order to assess any change in the water level by virtue of the landside which may block the river course causing major threat like that of the Parechhu formation during the year 2004.

To summarize that based on the observations derived from the analysis of different resolution of satellite data i.e., AWIFS, LISS III and LISS IV data products in the catchment area of Satluj Jal Vidyut Nigam Ltd. from upstream of Jhakari up to the Mansarover lake in the Tibetan region, it is concluded that the frequency of lake formations varies in each basin, which is evident from the different comparative analysis in all the three sub basins of the Satluj catchment. From the basin wise analysis, it is inferred that number of lakes delineated is much higher in the Tibetan Himalayan Region i.e., Upper Satluj basin in comparison to the other two basins i.e., Spiti and Lower Satluj basin, which signifies that Upper Satluj basin is more susceptible for the glacial lake formations and the permafrost leading to more lake formations as a result of which number of high-altitude wetlands as delineated from LISS IV data has increased. The increase in the number of small lakes further indicates that the rising temperature which is comparatively more on the higher regions than the lower regions and has adversely affected the Himalayan glaciers as a result of which the frequency of such pro glacial and supra glacial lakes is on higher side in comparison to the other categories of the lake formation. Considering the present trend of climatic variation and the increasing threat of climate induced hazards particularly from the glacial hazards, the space data has great potential and has been proved to be very useful in monitoring such developments on the higher reaches as it would not be possible by any other conventional methods. Thus, using space data, the variation in the spatial extent of different category of lakes can be estimated, which would help in assessing their vulnerability if any arising out of the increasing water spread considering the Guidelines on Management of Glacial Lake Outburst Floods (GLOFs), Landslide Lake Outburst Floods (LLOFs) of NDMA (MHA)-2020 of Govt. of India which suggest that detailed inventory of such lakes is required to be carried out on regular basis and with detailed analysis for the potential locations which includes field analysis as well. The recent tragedy of 2023 in the Sikkim Himalaya where a glacial lake has been busted causing very heavy damage to the infrastructure in the downstream areas besides the events that happened in Uttrakhand Himalaya in 2013 and 2021. Thus, the magnitude of such lakes as far as the destruction is concerned cannot be overruled. And hence all such lakes with area >10 hectare and the area between 5-10 hectare can be seen as the potential vulnerable locations considering the present trends in the climate science and the climate induced hazards threat thereof, for causing damage in case of bursting of any one of them by virtue of avalanche/landslide or any tectonic activity considering the high seismicity of the Himalayan region. Thus, a proper monitoring of all such lakes using high resolution space data is essential, which is not possible by any other conventional methods in order to avoid any eventuality like that of the Parechhu and other instances of GLOFs (Glacier Lake Outbursts Floods) in the Himalayan Region of Nepal and Bhutan and the recent incidents that had happened in Sikkim and Uttrakhand Himalaya, which will not only save the precious human lives but also the public and the Government property.

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