Son River originates near Amarkantak in Madhya Pradesh (MP) and joins the Ganga River, after a course of 784 km west of Patna. The Son is the second largest southern tributary of Ganga River. The Son River was one of the few rivers in North India which had wild gharial population. Thus, the Son Gharial Sanctuary (SGS) was established under the Project Crocodile to focus on gharial conservation and population recovery. A stretch of 210 km including 161 km of Son River, 23 km Banas and 26 km of the Gopad river was declared as Son Gharial Wildlife Sanctuary (SGS) in the year 1981, vide the Gazette notification No. 14-47-80-x-(2) under provision of Section 18(1) of the Wild Life (Protection) Act, 1972(Figure 1). The notification also includes 200m of land on either side of the river.
The headquarters of the SGS are located in the Sidhi district. The nearest railhead is in Rewa, which is approximately 100km to the west of Sidhi via National Highway 39. The nearest airport is at Allahbad, approximately 200km to the North of Sidhi via National Highway 30.

The region is defined as 'Sone Subzone – 1(d)', one of 26 hydro-meteorologically homogeneous Subzones of India (Central Water Commission 1987). It gets majority of the rainfall from the southwest monsoon in the months of June to September (Nair et. al., 2016). Temperatures during summer touch 46⁰C and during winter are as low as 7⁰C.

SGS is supposed to be second longest riverine protected area in MP, established with the purpose of conserving Gharial to provide them breeding/nesting habitat as well as for providing breeding /nesting habitat to other species of conservation importance such as Indian Skimmer and Indian narrow headed softshell turtle. Apart from Son River, its tributaries, Banas and Gopad also forms a part of the SGS.

Background of Action Plan

The National Green Tribunal (NGT) has been hearing the petitioner Nityanand Mishra and others on threats faced by SGS from different quarters and so far following interim orders have been passed by the NGT on this petition for saving SGS:

<table>
<thead>
<tr>
<th>Date</th>
<th>Orders</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/4/2015</td>
<td>1) Constitution of Forest Welfare Committees of villagers</td>
</tr>
<tr>
<td></td>
<td>2) Ban on movement of vehicles for transportation of sand</td>
</tr>
<tr>
<td>14/5/2015</td>
<td>1) Review on deployment of adequate force for patrolling of illegal mining</td>
</tr>
<tr>
<td>21/7/2015</td>
<td>1) MoEF directed to convene meeting with Ministry of Water Resources for maintenance of flow in the river</td>
</tr>
<tr>
<td>15/9/2015</td>
<td>1) Central Water Commission (CWC) constituted 6 member committee</td>
</tr>
<tr>
<td>31/7/2018</td>
<td>1) Committee constituted to</td>
</tr>
<tr>
<td></td>
<td>a) Prepare an action plan having in mind the object of –</td>
</tr>
<tr>
<td></td>
<td>1. Checking illegal mining</td>
</tr>
<tr>
<td></td>
<td>2. Conservation of gharials and turtles</td>
</tr>
</tbody>
</table>
In the last interim order on 31st July 2018, NGT constituted the Committee comprising of representatives from the Indian Institute of Forest Management (Bhopal), Wildlife Institute of India (Dehradun), Indian School of Mines (Dhanbad), National Judicial Academy (Bhopal), Ministry of Environment Forest and Climate Change and the District Collector of Sidhi - to prepare an action plan for checking illegal mining, conservation of gharials and turtles and maintenance of minimum ecological flow downstream the Bansagar Dam.

The Committee members - Mr. Yogesh Dubey an Associate Professor from IIFM Bhopal, Dr. Geeta Oberoi Professor NJA Bhopal and Mr. S.A. Hussein from WII Dehradun met regularly and held discussions on co-ordination, field work and literature review of the materials which were supplied to the committee by Ms. Rano Purohit from NGT and Mr. Sanjay Khobragade SDO from Sanjay Tiger Reserve who looks after management of SGS at present. Other members of the committee did not show any interest and in spite of repeated reminders remained silent. They neither joined for literature review nor for field visit.

After literature review of research studies conducted earlier and discussions, the field visit to SGS were carried out between 28 January 2019 to 31 January 2019. Mr. Yogesh Dubey from IIFM Bhopal, Dr. Geeta Oberoi from NJA Bhopal and Suyash Katdare researcher from WII undertook the field visit. During this field visit, the committee met the Collector Sidhi, petitioner Nityanand Mishra, Co-petitioner Ambuj Pandey, local villagers, STR staff allocated for protection of SGS, Mr. Vincent Rahim Field Director of STR, Engineer posted at Ban Sagar Dam, Legal representative from cement factory operational within range of 10 km of SGS and Mr. Sanjay Khobragade - to understand their viewpoint on threats faced by SGS.

The team visited following sites:

Plate 1. Signs of fresh illegal sand mining at Piproha on 28.01.19.
Plate 2. Illegally constructed access road to the river for transporting sand at Piproha on 28.01.19.

Plate 3. Jogdah one of the successful Gharial site 29.01.2019
Plate 4. Gharials basking in sun at Jogdah 29.01.2019

Plate 5. Son River at Rajghat
Plate 6. Son River at Kutlidah a potential site for Gharial nesting. One female Gharial was Sighted by the committee. 29.01.19

Plate 7. Old Sand Mining signs at Bichhi.
Plate 8. Bichi, a potential site for Indian skimmer nesting. 50 Skimmer were sighted on 29.01.19

Plate 9. Local Mela at patpara a source of disturbance with 200 mts of the river bed. 29.01.19
Plate 10. Son river at patapara a potential illegal sand mining site. 29.01.19

Plate 11. Son river at Kuldaha. Melas are held here regularly. 31.01.19
Plate 12. Son river at Akauri Ghat 31.01.19

Plate 13. Signs of mining at Rajghat, Churhat
Plate 14. Trench cum Walls structure made at Churhat to prevent trucks and trolley to reach river bed.

Plate 15. Son river at Churhat
Plate 16. Signs of illegally mined sand stored in villages at Bhitri. 31.01.19

Plate 17. Sand mining sign at Mahesan Ghat at Bhitri
Plate 18. Confluence of Banas and Son river at Bhavarsen, Shikarganj. Potential areas for Gharial conservation. 31.01.19

Plate 19. Bridges across river affecting flow of river. 30.01.19
Plate 20. Downstream of Bansagar Dam on 31.01.19

Plate 21. Downstream of Bansagar Dam from the centre of the dam
Plate 22. The Canal through which water is released to Bihar on Demand through 20x3 MW Hydro power station. There was no Discharge happening at the time of team visit on 31.01.19. The water in canal is only the leakage from turbines.
Plate 23, 24. The Contrast between Upstream and Downstream of Ban Sagar Dam. 31.01.19
Threats to SGS

From research studies conducted so far on the SGS, from various circulars, from offence registers maintained on SGS and from the field visit and discussions with all stakeholders, the team notes following problems:

(i) Existing and proposed water extraction projects have severely compromised the natural flow regime of the SGS. Water flow in the Son is at a critical stage. This level of flow modification is not beneficial to the riverine ecosystem. Riverine fauna are evolutionarily adapted to the natural flow regime and cannot alter their phenology with respect to the dam controlled flow regime.

(ii) The increasing illegal sand mining is threatening to further reduce the quality of an already deteriorated riverine habitat. Loss of vital nesting and basking sites will not bode well for the river as a sanctuary for riverine species.

(iii) SGS comes under the purview of the Field Director of the Sanjay Tiger Reserve. There is one Game Range for the management of SGS, supervised by a Superintendent (ACF) and one Game Ranger. Further, the range is divided into 4 circles and 13 beats, which are managed by Dy. Rangers and Beat guards/Game guards, respectively. Currently, the Superintendent (ACF) is the head of the field unit. The game ranger is assisted by 4 deputies and 7 beat guards. It is evident that the present staff strength is not enough to manage this sanctuary. Resources are spread thinly and are not enough to protect and govern a protected area spread over 200km. Thus, there is an urgent need for staff restructuring and increase to improve efficiency and effectiveness of actions. Inadequate staff increases opportunities for illegal activities such as mining and fishing to operate and proliferate within the sanctuary.

(iv) SGS was one of the few rivers in India which had a small breeding population of gharial from 2006, when the first nest was reported, till 2016, when the only adult gharial males were killed due to illegal fishing nets in the sanctuary. The current population of gharial stands at under 30 individuals (Jokhilal Prajapati pers. comm.) The construction of the Bansagar dam has heavily altered the flow regime of the Son river thus endangering lives of gharial population which need continuous flow of water.

(v) The current management plan of the sanctuary mentions that there are a total of 143 villages falling within the sanctuary boundary, i.e. 200m of land on either side of the river. Committee found that villagers are primarily involved in occupation of agriculture, fishing, cattle rearing, etc. The need for sand and easy access to the river has led villagers being involved in illegal sand mining and illegal fishing. This problem is further aggravated due to lack of settlement of rights, lack of staff for monitoring, lack of awareness within the villagers towards the sanctuary and lack of alternatives to reduce extractive pressures on the resources within the sanctuary.

(vi) Faunal records of the SGS show presence of aquatic reptiles such as gharial, mugger/marsh crocodile, freshwater turtles. Freshwater turtles that have been reported, are Ganges Softshell Turtle (*Nilssonia gangetica*), Indian Narrow headed softshell Turtle (*Chitra indica*), Red Crowned Roof Turtle (*Batagur kachuga*), Three Striped Roof Turtle (*Batagur dhongoka*) and Indian Tent Turtle (*Pangshura tentoria*).
Extensive studies on these species have not been carried out, however it was informed to the committee that STR will soon make results of its survey available to us. On avifauna, a total of 111 species of birds have been recorded from the SGS, of which seven species have been categorized as Near Threatened and ten species as Endangered under the IUCN Red List (Dilawar & Sharma 2016). The presence of breeding colonies with almost 80 birds (Nair & Katdare 2014; Dilawar & Sharma 2016) of the Indian Skimmer has been a record of conservation significance. In this context, the presence of breeding in the SGS adds a valuable record that requires attention with respect to its conservation.

(vii) There are two water extraction projects currently affecting the flow regime within the SGS. First is the Bansagar dam, a major reservoir which forms one of the boundaries of the SGS. It is a multipurpose project for irrigation and hydroelectricity on Son River situated at the junction of Shahdol, Satna, Katni and Umaria district in MP. The Bansagar dam is governed by a tri-state agreement between MP, Uttar Pradesh and Bihar. The construction of dam was started in 1978 and was completed in year 2006 and has since drastically affected the hydrology of the Son River. The second is a smaller project, on Gopad river outside the sanctuary limits, at Nigri, to provide water to the Jaypee Thermal Power Plant. The operations of these dams have drastically altered flow regimes of Son and Gopad rivers, in turn affecting fauna within the SGS.

(viii) The flow of water in the sanctuary has declined following closure of the Bansagar dam on river Son, some 6 years ago. With the final nala closure in 2006, the pattern of pools and sand banks and sand bars has undergone a huge change. The release of water is governed by the tripartite water sharing arrangement between the states of MP, Bihar and UP. While water to UP is supplied directly from the reservoir through a canal system, supply to Bihar is contingent upon the demands raised, by the Govt. of Bihar. Once the demand is raised the water is discharged into the main course of Son River (into the sanctuary, irrespective of the need of wildlife).

(ix) In the NGT order dated 14th Jan 2015, it was pointed out that for release of the water from the Bansagar dam is governed by a tripartite agreement between three States i.e. MP, UP and Bihar. Release of the water from the dam is to be carried out in accordance with the terms of such agreement and unilaterally, the state of MP within whose jurisdiction SGS is located, cannot release minimum required water from the dam so as to maintain connectivity between pools of SGS, particularly in the mating season. It was also mentioned in the Order that the agreement on sharing of the water in the river Son was made prior to the notification and creation of the SGS in 1981. Therefore, interests of SGS were never taken into consideration while drafting the agreement for sharing of water released from Bansagar dam by three states.

(x) Sandy habitats along the Son river (sand banks, mid river islands etc) form vital habitat components of threatened species, especially the gharial, Indian narrow-headed softshell turtle *Chitra indica*, Indian Skimmer *Rynchops albicollis*, among others. All these species require sand for nesting. Illegal Sand Mining is a prominent issue within the SGS and other riverine protected areas (Vagholikar 2003). Several locations along the Son River are notorious for illegal sand mining and often dredging the riverbed for sand.

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1 Minutes if 2**nd** meeting of expert committee on conservation planning of Son Gharial Sanctuary dated 13**th** March 2014. (3a)
2 Study Report on Water requirement for maintaining Son Gharial Sanctuary, (page no.5)
There is huge pressure exerted from all quarters to de-notify some sections of SGS to meet the demands for the sand. So much so that in 2003, there was a proposal for de-notifying a 31.25km section of the Son River within the SGS to meet the demands for sand.

(xi) Sand mining is directly affecting basking and nesting habitats of species in SGS. Mining of sand from the riverbed and river banks will negatively alter the river morphology, will increase sedimentation and turbidity and also disrupt the lateral connectivity within the river. Studies have already shown condition of Son River to be at a critical level with severely compromised river flows. Sand mining will only result in compounding what is an already sub-optimal riverine habitat. Any further degradation of this habitat will potentially make Son River uninhabitable for some of the most threatened fauna in the country. The data from offence registers of SGS as depicted in table 1 does indicate that there has been an increase in the number of cases with respect to the illegal sand mining in the sanctuary area. The information is about cases that were caught and processed by the Forest Department. There are many cases that go unnoticed due to inadequate patrolling as everyone informs that one truck generates illegal revenue of Rs. 12,000 and per night 1000 trucks generate illegal revenue of Rs. 1,20,00,000.

(xii) Illegal fishing is one the major threats to the survival of gharials and other riverine fauna. Cases of crocodilians and turtles dying due to strangulation in fishing nets are not uncommon. A rescue operation was carried out at Jogdah to free an adult female gharial from a fishing net entangled on its snout (Anjani Sharma pers. comm.). SGS suffered a major loss due to such fishing related mortalities when the only two adult gharial males at Jogdah died due to strangulation in fishing nets. This put an abrupt stop to gharial breeding and no gharial nest has been recorded after these deaths. There have also been reports of adult females at Kuthlideh dying due to fishing nets (Lallu Thakur pers. comm.).

(xiii) Son River within the limits of SGS is a highly regulated and transformed river ecosystem as a result of the Bansagar Dam and its reservoir operations, and other extractions from the Son and its tributaries. In the wet-season, discharge is governed by inflows into the reservoir, reservoir capacity and safety considerations of the dam. The sediment and nutrient inflows associated with peak flows are largely eliminated by the Bansagar Dam in the sanctuary. Even in the event of large releases from the reservoir, sediment is still largely trapped in the reservoir. Sediment supply, mobilization and deposition have been severely curtailed downstream of the dam, and the area of sand has reduced by almost 8000 hectares between 2003 and 2014 (Singh & Parihar 2015). In addition, illegal sand mining is exacerbating the situation. The siltation of reservoirs and consequent loss

Table 1 Summary of offenses related to illegal sand mining

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Year</th>
<th>Number of Offenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2012</td>
<td>37</td>
</tr>
<tr>
<td>2</td>
<td>2013</td>
<td>61</td>
</tr>
<tr>
<td>3</td>
<td>2014</td>
<td>68</td>
</tr>
<tr>
<td>4</td>
<td>2015</td>
<td>39</td>
</tr>
<tr>
<td>5</td>
<td>2016</td>
<td>39</td>
</tr>
<tr>
<td>6</td>
<td>2017</td>
<td>102</td>
</tr>
<tr>
<td>7</td>
<td>2018</td>
<td>97</td>
</tr>
<tr>
<td>8</td>
<td>2019 till January</td>
<td>4</td>
</tr>
</tbody>
</table>
of storage capacity is a major concern all over India (Central Water Commission 2015).3

(xiv) Based on the studies carried out by Nair & Katdare (2013, 2014), the Government of MP commissioned a study in 2015, (Nair et. al., 2016) to ascertain ecological flow regimes of the SGS (Son, Banas and Gopad rivers). In 2015, three instances of unseasonal releases were recorded –

1. Released from Bansagar dam during (February-March 2015) leading to a rise of 57cm in the water level

2. From the Jaypee controlled Nigri dam during April which lead to a rise of almost 15 cm in the water level, inundating several exposed sand bars and islands. Subsequently, Indian Skimmer nests were also destroyed.

3. Another release from the Bansagar dam in June lead to an increase of almost 80 cm in the water level. This release again inundated and damaged the second nest clutch of Indian Skimmer.

The discharge during peak lean season, i.e., during the month of May was calculated to be 1.03 m³/sec in the Son river.

Table 2 – Comparison of natural and measured discharge during 2015 (from Nair et. al., 2016)

<table>
<thead>
<tr>
<th>Month</th>
<th>Simulated natural discharge* (m³/sec)</th>
<th>Measured discharge in 2015 (m³/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb</td>
<td>30.28</td>
<td>11.66</td>
</tr>
<tr>
<td>Mar</td>
<td>26.97</td>
<td>24.52</td>
</tr>
<tr>
<td>Apr</td>
<td>17.32</td>
<td>1.66</td>
</tr>
<tr>
<td>May</td>
<td>13.7</td>
<td>1.03</td>
</tr>
</tbody>
</table>

Tharme et. al. 2002, have described the river condition, based on the flow, such that 10% of the average annual flows represents a poor condition while 60% and above represents the optimum condition. The peak lean season (April – May) measurement shows that the measured discharge is lower than 10% of the natural flow regime. River flows at 10% or less than 10% of the natural flows represent a poor condition of a river, with water availability at the lowest environmentally acceptable level.

Plan of Action for saving SGS

The main objective of this report is to propose conservation action plan for SGS based on which a management plan can be developed for improved conservation and scientific management of the Sanctuary. Accordingly, the Committee recommends that -

(i) SGS is functioning with a threadbare staff. This point has also been highlighted in the current management plan of the sanctuary (Khobragade). SGS should be equipped with a restructured staff and a new, technically sound management plan to help the managers in operation of the sanctuary. It is proposed that the sanctuary be further split into four ranges. The number of beats has also been proposed to increase to 40 and accordingly increasing the number of game guards/beat guards to 40. The number of armed personnel should be increased to assist in patrolling duties. There should also be at least

3 Estimation of ecological flows in the Son Gharial Sanctuary (Son River, Madhya Pradesh) with a focus on gharials Gavialis gangeticus.
one mobile patrolling unit consisting of beat guards and army personnel to increase the intensity and effectiveness of patrolling. Boat patrols should also be introduced, especially around areas with critical wildlife habitat and areas with greater incidents of threats. Boat patrols will help in apprehending illegal fishers as the fishermen often escape from land patrols by simply crossing the river. Increasing ranges and management units to be controlled by appropriate number of personnel will help in distribution of duties which will, in turn, increase effectiveness of actions. Also, within SGS a dedicated team of personnel for monitoring of gharial, turtle and Indian skimmer should be constituted and the same should not be burdened with any other work like stopping of illegal mining etc. Further, services of full time hydrologists, fresh water ecologists to be taken to continuously monitor river and sediment flow. Also, internship to be provided to students from IIFM, law schools and WII by providing them decent stipends, accommodation, food and vehicles for travel. These interns will help in generating ecological information on daily basis which can be used for developing effective management strategies for SGS.

(ii) The need of freshwater is only going to increase with an increasing population. Water is a primary domestic, agricultural and industrial requirement. Demand for water will further add pressure on the freshwater ecosystem, leading to altered flows, disrupted hydrological cycles of the ecosystem and eventually, deteriorated water quality. The pressure caused by high demand can be reduced considerably by promoting alternatives such as rain water harvesting, water conservation in all areas of industry, agriculture and domestic use. The forest department should try to identify communities and villages which are dependent on the river for fishing and as such, a program should also be attempted to address fishing pressures by setting up co-operatively managed inland fisheries in common village lands. It is also recommended that such programmes promote only indigenous species so as to prevent the risk of exotic/invasive species entering the SGS. These programs should be aimed to offer opportunities to significantly reduce extractive pressures and disturbances on the SGS and simultaneously create livelihood opportunities. The forest department will have to form eco-development committees (EDC) for every village to carry out activities like (a) Water harvesting to reduce the dependency on the river water, (b) Inland fisheries and poultry farms to provide alternatives to river fish so as to reduce illegal fishing, (c) managing sand quarries which are outside SGS so that a portion of the generated revenue can then be utilized for the development of the EDCs.

(iii) A major hurdle in reducing the dependency of villagers on the river is the incomplete process of settlement of rights. Obtaining the final notification of SGS is also necessary to aid the process of right settlements. It is suggested that this process be initiated and completed at the earliest. Till then the forest department should carry out regular awareness programs to help reduce the gap between the forest department and the villagers. Forest department should involve local people by creating awareness regarding the integrity of the SGS, and the need to protect it. The department can work in tandem with the locals to provide alternatives to reduce dependency on the resources of the sanctuary. Education and extension programs be carried out in 122 villages on conservation values of SGS so that people are supportive to the cause of conservation.

(iv) Fishing inside a protected area has been completely banned under the Wildlife Protection Act (1972). The reduced water level in the Son river has concentrated most of the riverine fauna within disjointed, deep pools of water along the river. Threatened fauna such as the gharial, Indian skimmer, carnivorous turtle species viz., Ganges softshell turtle mainly feed on fish. Illegal fishing, thus, targets the main food source of these species. This conflict gets compounded because illegal fishing happens mainly in the same habitats where the
above mentioned species occur. It is therefore suggested that fishing be also considered a crucial factor to be dealt with for its potential in causing disruption to existing population of threatened fauna within the SGS. Control of fishing is solely the responsibility of the Forest Department. Increased patrolling is necessary to identify locations of intensive fishing. Areas with critical habitat such as nesting sites of turtles, crocodiles and birds should be patrolled with greater intensity. There should be dedicated staff to check fishing.

(v) Unseasonal releases and abrupt ceasing of water from the Bansagar dam shows that the water flow within the SGS fluctuates between -68.63 m³/sec and +136.23 m³/sec (deviation from the natural flow regime) based on dam operations. Riverine fauna are evolutionarily adapted to the natural flow regime and cannot alter their phenology with respect to the dam modified flow regime. This was evident when nesting colonies of skimmers got inundated due to unseasonal release of water from the Nigari dam on the Gopad river (Nair & Katdare, unpublished report 2015). The report of Nair et. al. 2016, has shown that the river flow affected by the operations of the Bansagar dam is less than 10% of the expected natural flow. This resultant condition of the river represents an environmentally poor state and is not viable for maintaining ecological processes. As recommended by Nair et. al., 2016, it is extremely important to ensure that any unseasonal water release from the Bansagar dam does not exceed 40 m³/sec or 3.456 MCM/day in the dry-season. We thus propose the flow regime to be followed to maintain the ecological flows of the Son River. The minimum flow as described in table 3 must be maintained month wise to ensure the optimum flow in river from dam site.

<table>
<thead>
<tr>
<th>Month</th>
<th>Simulated natural discharge (m³/sec)</th>
<th>Required minimum discharge (@60%) (m³/sec)</th>
<th>Measured discharge in 2015 (m³/sec)</th>
<th>Minimum flow required to achieve 60% of natural flow (m³/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>November</td>
<td>68.63</td>
<td>41.178</td>
<td>-</td>
<td>41.178</td>
</tr>
<tr>
<td>December</td>
<td>55.11</td>
<td>33.066</td>
<td>-</td>
<td>33.066</td>
</tr>
<tr>
<td>February</td>
<td>30.28</td>
<td>18.168</td>
<td>11.66</td>
<td>6.508</td>
</tr>
<tr>
<td>March</td>
<td>26.97</td>
<td>16.182</td>
<td>24.52</td>
<td>-8.338</td>
</tr>
<tr>
<td>April</td>
<td>17.32</td>
<td>10.392</td>
<td>1.66</td>
<td>8.732</td>
</tr>
<tr>
<td>May</td>
<td>13.7</td>
<td>8.22</td>
<td>1.03</td>
<td>7.19</td>
</tr>
<tr>
<td>June</td>
<td>57.64</td>
<td>34.584</td>
<td>-</td>
<td>34.584</td>
</tr>
</tbody>
</table>
(vi) A cumulative impact assessment of all existing and proposed projects on the Son, Banas and Gopad rivers has to be carried out to formulate a more holistic strategy of maintaining eco-flows for SGS. Any further development on Son, Gopad and Banas should be seen only in light of the findings of the cumulative impact assessment study. The study be carried out by the MOEF & CC. Reportedly, 298.6 MCM of water has been allotted for new projects on Gopad river which will likely lead to a further loss of 9.5 m$^3$/sec of discharge from the Son river. Other projects are in the form of a drinking water project on Banas river for 31 villages and the town of Sidhi. Both Banas and Gopad rivers are extremely vital towards the survival of the Son River and achieving the conservation potential of the SGS. Flow measurements from 2015 indicate that Banas and Gopad contribute 68% and 47% of the discharge of Son river respectively. (Nair et. al., 2016; Nair and Ktdare, unpublished report 2015). In this respect, it is extremely important that a hydrology monitoring mechanism be established to regularly evaluate and maintain the ecology of the SGS.

(vii) Based on “Report on the current status of wildlife of the Son Gharial Sanctuary” by Madras Crocodile bank, the Committee is of opinion that at least seven crucial areas must be accorded full protection and intensive management inputs to facilitate propagation of wildlife. These areas should be secured (Chain link fenced to keep it free from outside disturbance), with watch towers, /patrolling camps, round the clock patrolling. These areas may be designated as inviolate core areas or critical wildlife habitat. All future gharial, mugger and turtle conservation and breeding program must be centered around these sites. The seven critical areas identified by the Madras Crocodile Bank team, are as follows.

1) Anahara
Extent: N 24°11'16.73" E 81°20'4.90" to N 24°11'45.38" E 81°22'1.25"
Max. recorded depth: 45 ft

2) Terideh - Bhaversen Ghat - Kadariya
N 24°15'36.09" E 81°25'44.20" to N 24°18'41.30" E 81°28'46.77"
Max. recorded depth: 13.9 - 18 ft

3) Jogdah - Kunjunh - Nakjhar
N 24°30'20.30" E 82°7'49.03" to N 24°32'20.20" E 82°12'12.49"
Max. Recorded depth: 14.6 - 64 ft; 19.5 ft

4) Khutali - Munnadah - Kajardah
N 24°32'19.06" E 82°172.99" to N 24°33'35.18" E 82°21'19.83"
Max. recorded depth: 8.2 ft; 8.6 ft, 12.8 ft

5) Rajghat - Kutlidah - Bichhi
N 24°33'40.30" E 82°23'11.77" to N 24°32'17.81" E 82°27'58.78"
Max. recorded depth: 9 ft

6) Harma - Karwala
N 24°31'6.41" E 82°31'17.82" to N 24°31'47.38" E 82°33'11.83"
Max. recorded depth: 9.6 ft; (Karwala pool not measured)

7) Nagdah (Gopad River)
N 24°28'57.30" E 82°16'41.98" to N 24°29'27.85" E 82°17'0.74"
Max. recorded depth: 66 ft
By trapping sediment in reservoirs, dams interrupt the continuity of sediment transport through rivers, resulting in loss of reservoir storage, reduced usable life, and depriving downstream reaches of sediments essential for channel form and aquatic habitats (Kondolf et al. 2014). Therefore, ecological flow regime by definition should include sediments and nutrients, which are crucial for downstream ecosystems. Sand and silt deposits are crucial for creating and maintaining sandbanks and emergent sandbar habitats of gharial, turtles and Indian skimmer. If sediment supply is drastically reduced and sand mining depletes deposits within the sanctuary, the habitat requirements of these species cannot be met. Therefore, sediment management approaches are recommended to sustain reservoir capacity and minimize environmental impacts of dams.

The increasing illegal sand mining is threatening to further reduce the quality of an already deteriorated riverine habitat. Loss of vital nesting and basking sites will not bode well for the river as a sanctuary for riverine species. The local administration, inclusive of the police force and the forest department is responsible for controlling sand mining in SGS. Presently, 32 sand mines are operating, with the permission of the forest department, outside of the sanctuary limits. There should be an appraisal of these quarries to determine the income generated by these quarries. In 2003, there was a proposal to de-notify a stretch of 31.25km of SGS to lease it out for sand mining (Vagholikar 2003). The management plan of the sanctuary mentions that the Collector of Sidhi had issued an order No./4/A-82/96-97 dated 17.02.2006 in order to de-notify the above mentioned stretch inside the sanctuary. However, this proposal was rejected by the then Chief Wildlife Warden of the state of MP. The committee is of opinion that DE-notifying any stretch of SGS would be disastrous for survival of Gharials, turtles and Indian Skimmer in SGS.

There is a need to alleviate the patrolling effort especially in areas where sand mining happens routinely and regularly. The Committee therefore proposes for creation of a special task force comprising of armed Police Personnel and armed Forest Guards to curb sand mining in SGS. Major roads that are used for transportation of the sand should be fitted with infra-red cameras to monitor the movement of vehicles in night, as all the illegal sand mining happens only during night.

Innovative steps taken in the past by district administration like re-dumping illegally stored sand piles in villages back into the river, imposition of section 144 CrPC in villages in proximity of sanctuary, banning transport of sand, fixing obligatory points and limited routes for transport of sand had considerably reduced sand mining in SGS and also resulted in seizure of about 102 vehicles during last two years and confiscation proceeding against 87. The committee is of opinion that such innovative ways should be repeated by administration to help reduce the extent of sand mining and also discourage people involved in it. A joint force of SP of Sidhi, Satna, Singrouli, Shadol and Rewa must meet every fortnight for minimum 3 years on issue of sand mining as everyone informs that one truck generates illegal revenue of Rs. 12,000 and per night 1000 trucks generate illegal revenue of Rs. 1,20,00,000. Collectors of all 5 districts should also meet once every quarter at office of commissioner for a stock taking meeting to discuss affairs of SGS.

It is evident that the suitable habitat for gharials has now deteriorated, along with an increase in anthropogenic pressures. In this respect, it is recommended that NO new release of gharial, mugger or any species of freshwater turtles be carried out in SGS.
until such time that all the recommendations and suggested mechanisms are in place and that the habitat in the SGS has recovered to acceptable levels. The distribution of flora, fauna, and various development activities including sand mining sites and intensive fishing zones should be mapped using GIS domain. If Chambal could be a success story, so could be SGS. It was because dedicated teams for gharial, turtle & Skimmer could be employed. These could be employed even on contract basis - young guys from IIFM / WII / NGOs like ATREE could be employed and given the task of training and educating villagers.

(xiii) A technically sound and updated management plan should be developed to help the department in reviving the sanctuary. The present plan needs drastic improvement. The Plan must take into account staff restructuring and strengthening to tackle the illegal activities threatening the integrity of the sanctuary. Science based management plan focused on species recovery with respect to gharial, turtle and skimmer be prepared and vetted by fresh water ecologists of country. The State Forest Department should prepare a proposal under CAMPA funds to seek special grants for management and protection of SGS.

(xiv) No new Bridges should be constructed on Son river all along the stretch that forms the boundary of SGS. If at such projects are extremely important only suspended bridges should be permitted and construction should be carried out in seasons not interfering with the Gharial, mugger, turtle and Indian Skimmer nesting and movement.

(xv) PWD guest house at Shikarganj at bhanversen may be handed over to SGS administration as Shikarganj is a crucial location for future Gharial conservation program at Teridah and since it is located at a vantage point can also be used for long distance monitoring and surveillance.

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