

# Understanding Mansagar Lake Governance using Social-Ecological Systems (SES) Framework

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Governing social-ecological systems such as urban lake systems are inherently complex and how to study them is further complicated. Researchers and analysts have taken help of theory or hypotheses or assumption or pre-suppositions to guide the selection of an effective analytical focus. Here the approach taken is to just understand without getting into solving a problem or proving something. The paper is about understanding the current urban lake governance in India using the case of Mansagar lake governance. Researches from sustainability and complexity science believe that selecting 'appropriate' framework of analysis is crucial in understanding complex systems such as urban lake governance. The multi-tier social-ecological systems framework, developed by Elinor Ostrom, is used to analyze the Mansagar lake governance particularly focusing on the collective action of the actors and the ecological performance of Mansagar lake. Mansagar lake is a classic example of complexity and sustainability pertaining to urban lake deterioration, improvement and the linked governance. The SES framework is a nested ontological framework. It is a decomposable system in which the main variables namely, resource systems, resource services and units, governance systems and actors, are unpacked for explanation. The framework allows connecting the causal links of reasoning and harnessing the complexity involved in urban lake governance. The paper hopes to contribute to the current methodological and practical debates on studying complex social-ecological systems such as urban lakes and envisages using the analysis for building a theoretical framework for analysing urban lake governance in India.

**Keywords:** urban lake, governance, social-ecological system, variables, Mansagar.

## 1. INTRODUCTION

In a given socio-economic and political setting of a place in time, the governing architecture of urban lake systems is attributed to the following ecological aspects: lake system characteristics comprising of lake bed, catchment area, inlet/outlet drainage channel and water quantity and quality; different values generated by lake system/s such as recreation, drinking water, irrigation, fishing and now even wastewater sink; and other related eco-systems of the lake system/s such as infrastructures, pollution pattern and the built environment. These ecological aspects have specific conditions for sustenance; and their provision, production, maintenance, and management require specific governance involving array of actors and governing mechanisms. The actors and the governing mechanisms are from meta-constitutional, constitutional, collective choice and/or operation levels of action. Governing mechanisms involve interactions such as financing, monitoring, evaluation, sanctioning, administration, technical support, information, use, abuse, feedback and more. It makes the governance polycentric and the whole system complex. Harnessing complexity is challenging, but worth understanding.

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Amidst the complex urban lake governance, the common patterns of interactions observed between the actors, the governance system, and the resource system are: the urge to collective action towards the sustainability of urban lakes. The aim, thus, is to understand the fundamentals of collective action and sustainability of urban lakes. The objective is to dig deeper into the functioning of the organizations working collectively towards Mansagar lake maintenance and assess the ecological conditions of Mansagar. The empirical inquiries are:

1. *How do actors collectively interact in the maintenance activities of Mansagar?*
2. *What is the perceived ecological condition of Mansagar Lake and its maintenance?*

The empirical inquiries require explicit understanding of how and what. Implicit in the inquiries is 'who', which is a categorical identification of the actors in the collective action. The 'how' is the mapping the actions of the actors with other actors and towards the sustainability of the lake. The 'what' involves finding about the sustainability of the lake. Implicit also in the inquiries is the general assumption that specific (ideal/good) kind of governance such as collective action may lead to sustainable urban lakes such as improved lake conditions as represented by causal relation: *Collective action* → (may lead to) → *Sustainable urban lakes*,

in which, collective action refers to the construction/ constellation/ configuration/ composition/ network/ structure of multiple actors with multiple facets who network together in multiple actions (functions) at multiple levels and use multiple governing mechanisms (regulations, strategies, instruments and resources) in order to produce certain outcome/s such as sustainability of the lake (adapted from Bressers and Kuks, 2009; Ostrom, 2010; McGinnis, 2011). Collective action is also reflected in form of: network governance, interactive governance, integrated management, adaptive management, resilient governance, robust governance, sustainable management/governance, participatory planning, collaborative planning, and etcetera. The unit of actor in collective action is mostly individuals. Here, the actors are the organizations those who govern and individuals those who are governed in the process. The organisations are identified linked to the specific lake maintenance activities to understand the collective action situation.

in which, sustainability refers to the physical existence or intrinsic value (Pearce and Moran, 1994) of a lake in the form of its land mass, water quantity and quality over time. Urban lake sustainability is a policy objective and objective of the actors in collective actions. Sustainability is measured as existence of the lake over time. The ecological performance of the lake from individuals' perception, 'if improving' or 'ensuring existence' is used as proxy to measure sustainability.

Understanding the governance system that leads to deterioration or improvement of urban lakes system is challenging even though there are several available scientific tools, techniques and methods to do so. There are three compounding reasons. First, urban lake systems are inherently complex and dynamic social-ecological systems and its comprehensive study is challenging. Second, scientific disciplines in which lake system and governance studies have evolved use different concepts, languages, interpretations and approaches to explain the already complex urban lake governance and often fail to cumulate and give w/holistic picture. Less is done on linking those studies which may help avoiding repetitions and advance in actual

problem solving. Finally, there is a problem of finding one theoretical perspective that is sufficient to analyze and comprehend w/holistic picture of what is actually happening. Amidst the existing frameworks to study social and ecological systems in various disciplines and organizations, the Social-Ecological Systems (hereafter referred as SES) Framework, developed by Elinor Ostrom in 2007, is used to analyze urban lake governance. The focal action situation of the SES framework is composed of the main variables: the lake system, the lake services and units, the actors involved and the lake governance system. A case of Mansagar lake governance is used for case study analysis.

The paper is divided into six sections including the introduction. In the following, the background of the SES framework and the Mansagar Lake are first described. It is followed by the research methodology and the conceptual framework. Then Mansagar lake governance is analyzed using the SES framework. The paper concludes with a discussion on the SES framework and its relevance to understand urban lake governance in India.

## 2. MANSAGAR LAKE

Mansagar Lake is a typical water reservoir, traditional known as water harvesting structure in India (Agarwal and Narain, 2001). It is constructed amidst the picturesque landscape of hilly surroundings. The characteristics of Mansagar are linked to the social and ecological activities of the lake, the shoreline, and the surroundings and consist of the following and as presented in figure 1.

1. The Lake: The current water spread area of the lake is approximately 333 acres. Almost double the area is covered with diverse shoreline activities. The lake is recipient of the waste water from the city of Jaipur. The average and maximum depth of water in the lake are approx 15 feet and 30 feet respectively.
2. *Jal Mahal* (water palace) is the historic water palace located in the middle of Mansagar. It was constructed to beautify Mansagar. *Jal Mahal* was a leisure place of the royal family for fishing, hunting and water sports. It was unused for five decades over property right dispute between the royal family and the government. It deteriorated to the extreme until its recent restoration. People recognize Mansagar Lake with *Jal Mahal*.
3. The western edge of the lake is thronged with urban development activities including the lake promenade which is popularly known as Chaupati. The promenade is the heart of Mansagar. It abuts a busy road with recreational, commercial, institutional and residential developments.
4. Mansagar dam on the east is a historic structure with a garden on the top. The dam is currently unused. The overflow of the lake is diverted adjacent to the dam.
5. The south side consists of the newly reclaimed land, the inflow drainage channels from the city and the main urban catchment area of the Jaipur old city.
6. A newly constructed lake drive road leading on the north is the natural hilly side. There are two temples on the lake drive road. It is a popular place for walkers and is also used for sports and fitness events.
7. The islands are homes to several bird species including migratory birds.
8. Two sedimentation tanks are carved out from the lake in the north and one sedimentation tank is within the lake on the outlet side on the east end.

9. The hills on the north and west set the picturesque background for Mansagar and form the main catchment areas of the lake.



Figure 0-1. Mansagar lake environs

The degradation of Mansagar began in the nineteen sixties, with a decision when the local government planned to dispose the Jaipur city's waste water into the lake. The background of this decision was the growing challenge of the disposal of the city's waste water; and the lake appearing as a potential source of disposal. This is a typical situation of urban lakes and rivers in India. After several years of degradation bringing the lake to the state of despair, a decision to restore Mansagar came in the early 2000. The decision was led by few political leaders and bureaucrats of the state. It brought several organizations to a collective agreement to find optimal solution for the restoration of the Mansagar Lake. A high level committee was formed and Mansagar Lake Restoration Plan was chalked out. The restoration activities were distributed among the local government and private organizations. The restoration work began in 2004-05. With few years of implementation of the restoration plan, improvements are evident in the shorelines, lake water quantity and quality. The sustainability of Mansagar is now high in agenda, particularly physically and logistically. During this time, few civil society organizations objected the restoration process and filed legal case against the involved organizations. The Rajasthan High Court ordered (May, 2012) to 'un-do the restoration efforts' which created an outrage among the local people and the 'Save Mansagar Campaign' was launched. The case has further moved to the Supreme Court of India. The Supreme Court of India has directed the case to the sessions (local) court in Jaipur for further investigation. Mansagar is a classic situation of 'tragedy of the win of social-political-legal battle over the ecological struggle of a lake' (Bal, 2012).

### 3. SES FRAMEWORK

SES framework is linked to the concept of social-ecological system. Anderies, Janssen and Ostrom (2004) in the study on robustness of SES from institutional perspective define SES as an ecological system intricately linked with and affected by one or more social systems, in which an ecological system is loosely defined as an interdependent system of organisms or biological units and social system broadly

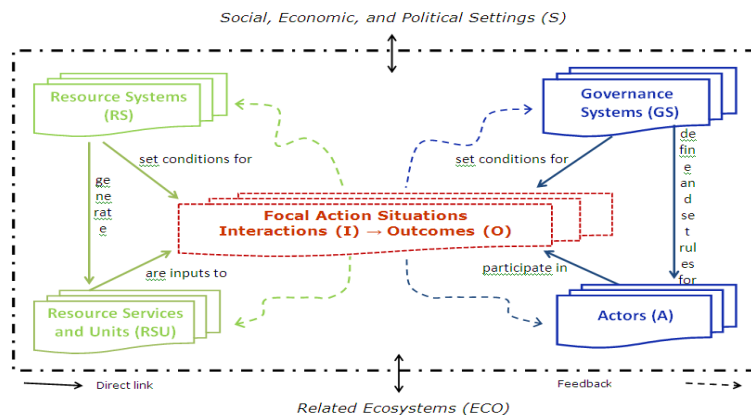
meaning that humans tend to form cooperatives and interdependent relationships with others of one's kind (from Merriam-Webster Online Dictionary, 2004). SES also refers to the subset of social systems in which some of the interdependent relationships among humans are mediated through interactions with biophysical and non-human biological units. The social system and ecological system are linked and both contain units that interact interdependently and each contains interactive subsystems as well. For interlinking of SES, Ostrom refers to the foundation of self-organisation of the social systems like the self-rejuvenating processes evident in the ecological systems (Ostrom, 2011). Ecologists have also recognized the complexity and the necessity of recognising the non-linear, self-organising and dynamic aspects as well as the multiple objectives and the spatial and temporal scales involved in the study of ecology and institutions (Hess and Ostrom, 2004).

To analyse a SES, it is necessary to have comprehensive understanding of the system and the processes that lead to changes in the system; basically how the system actually functions. A framework provides that structure. The focus here is on the 'framework' to study social-ecological systems. A framework organizes diagnostic and prescriptive enquiry and provides the most general set of variables that should be used to analyze all types of settings relevant for the framework (Ostrom, 2005). The purpose of the SES framework is to build common understanding of the social and ecological systems amongst various disciplines in order to overcome the linguistic and disciplinary barriers that result in the varied and often conflicting understanding of the social-ecological systems (Ostrom, 2007). SES framework helps scholars to organize and share a common language and a logical linguistic structure for classifying factors that deemed to be important influences on the types of SES under observation (McGinnis and Ostrom, 2011).

SES framework is a structure or composition of certain important variables belonging to the social context and ecological context, for the purpose of understanding/ analyzing/ assessing/ evaluating a social-ecological system in question/ observation/ problem/ interest. It is a nested ontology with multiple tiers that is intended for systematic diagnosis of the structure and outcomes of complex, multitier social-ecological systems (Ostrom, 2011). The basic idea of SES framework is to provide scholars with key social components and ecological components and their sub-components and to indicate how they relate with each other. These components are called variables. The main variables of the SES framework are:

1. Resource system (RS) refers to the bio-physical characteristics of the resource. The land mass and the water encompassing a lake system are considered.
2. Resource services and units (RSU) refers to the functions generated by resource system. They are referred as the total economic value of the resource (Pearce and Moran, 1994). The RS and RSU are basic in the SES framework.
3. Actors (A) refer to the different organizations. Actors also refer to the local people who live in the lake surroundings and the visitors to the lake. Actors are making choices and taking actions which are affected by the governance systems within a certain socio-economic-political setting of a place in time.
4. Governance systems (GS) refer to rules-in-use (Ostrom, 1990) or the governing mechanism (at operational level). GS allocates (or fail to allocate) authority, information and resources, structure of decision making, allocate accountability, and create property rights and the likes for the actors and the resource system.

5. Socio-economic, political settings (S) is the broader geo-political (including market and cultural) context within which the focal resource system, the actors and the governance systems are located.
6. Related Ecosystem (ECO) is the broader ecological (including physical-urban externalities like infrastructure) context within which the focal resource system, the actors and the governance systems are located.
7. Interactions (I) is identified as exchange between: actors and resource systems; actors and resource services and units; actors and governance systems; governance systems and resource systems; governance systems and resource services and units. Known examples from CPR are harvesting, deliberation, lobbying, conflict, and several others.
8. Outcomes (O) are general concepts that include performance of both the systems: social systems (for example efficiency, equity, accountability) as well as ecological systems (for example overharvesting, resilience, sustainability) and externalities of the social-ecological system in analysis (1-8 adapted from Ostrom, 2007, 2009; McGinnis, 2010). The SES framework representing the main variables is presented below in figure 2.



**Figure 0-2. The SES framework**  
(Source: McGinnis and Ostrom, 2011)

The rectangular boxes denote the building blocks. The solid arrow is the direct link and the dotted arrow is the feedback. The feedback paths link the outcomes back to the variables, thus denoting a dynamic overall system (McGinnis and Ostrom, 2011). SES framework enables scholars to organize analyses of how attributes of a resource system, the resource units generated by that system, the users of that system, and the governance system jointly affect and are indirectly affected by interactions and resulting outcomes achieved at a particular time and place. These variables form the focal action situation (Ostrom, 2005). The multiple boxes for each variables denote the potential for concurrent operation of multiple instances of each of the main variables their combinations animating multiple action situations.

Understanding a complex whole (social-ecological systems) requires knowledge about specific variables and how their component parts (sub-variables) are related. While the main variables represent a broad scheme of the SES structure, to diagnose the causal patterns that affect interactions and outcomes among the main variables, it is necessary to look at a set of sub-variables that are contained within the main variables. Several attributes are identified that ascribe/characterise/define

and give meanings to the main variables, i.e. the main variables are classified into several sub-variables (Ostrom, 2009). The sub-variables help to define, group and classify the main variables in the tiered ontology. The sub-variables are established concepts and are defined earlier by CPR scholars<sup>2</sup> and other scholars who study human behaviours, ecology, governance, and institutions. Elaborate list of sub-variables are presented in Ostrom, 2007, 2009; and Nagendra and Ostrom, 2011.

Identifying and analysing the sub-variables is what SES studies are about. Logically, all the sub-variables are possible to use in one study (Bal, 2009). Using too many sub-variables, on one hand, is too general to find solutions for the problems, but on the other hand, provides a general understanding and overview of the situation of the SES in observation. (Ostrom, 2009) warns for using too many sub-variables in one study. Here, few sub-variables are used to understand the complexity involved in Mansagar lake governance and simultaneously learn about the SES framework.

#### 4. RESEARCH APPROACH

Following are set up for analyzing Mansagar lake governance using SES framework:

**The levels of analysis** are operational level, collective choice level, constitutional level, meta-constitutional level (Ostrom, 2005; McGinnis, 2010). The resource system is at operational level and so is its analysis. The actors are from collective choice level however, they are involved at multiple levels at a time. The actors and the governing systems from the collective choice level and operational level are considered for analysis. **Interactions** in the governing mechanisms commonly include: provision, production, maintenance, management, financing, monitoring, evaluation, sanctioning, technical support, administration, information, subtractable use, non-subtractable use, abuse, feedback, deliberation, conflict resolution, investment, lobbying, self-organizing, networking and many more. Collective action involved in the maintenance activities is the interaction looked upon. **Outcomes** linked to the resource system are measures such as overharvested, resilience, biodiversity, sustainability or simply ecological performance of the resource system. The ecological performance of the lake is the analyzed which is referent to sustainability. Sustainability is also the expected outcome of the actors and the governance system. **Control variable** orients the observed interactions and outcomes. Explicit in the interactions and outcomes is the purpose that controls them, in other words collective action for what and sustainability for what? The desired resource services and units (RSU) set by the actors and the governance system and generated by the resource system is the control variable. The resource services and units encompass the framework of total economic value. The different values generated by the lake system create adjacent action situations (and different collective actions) at operational level. They also affect other levels. The TEV is referred as value. Of the several values, the existence (or intrinsic value) of the lake as a physical open space (direct use value) controls one action situation that is across the multiple levels and across multiple arenas within a level. If the lake exists 'physically', then the other values can be generated through it. The existence value in this sense is referent to sustainability (VanAst, Bouma and Bal, 2013). The existence of the land mass, the water quantity and water quality over time are looked at. The **entry to the**

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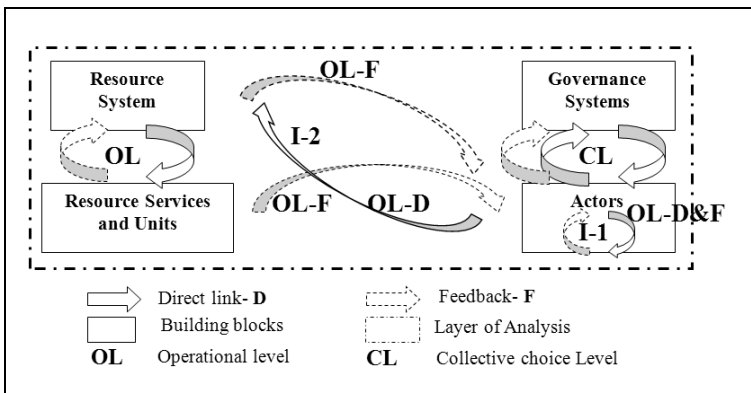
<sup>2</sup> Such as Bloomington Workshop, Resilience Alliance, Complexity Group, Sustainability Science etc.

**framework** is the expected outcome which is ecological restoration of Mansagar set by the actors involved in collective action. In addition, collective action performance is the outcome selected in the research. To put simply, how Mansagar is currently maintained? and what is the condition of Mansagar?

For a particular collective action situation to improve the ecological performance of a lake system in order to produce certain value for the society; the multiple interactions exist simultaneously such as:

- Nested-ness of the bio-physical diversity of the lake systems to produce certain value. RS→RSU
- Nested-ness of the institutional diversity in the collective action of the actors. A→A
- Nested-ness of the institutional diversity in the collective action of the actors and the rules-in-use. A→GS→A
- The configuration of the rules-in-use and the actors to maintain the bio-physical aspects of the lake to produce certain value. (A→A)(A→GS→A)→RS→RSU

The multiple interactions within one action situation are animated to construct the conceptual model. It is presented in figure 3. The figure shows that in a given situation, actors work collectively towards the resource as well the governing systems in order to ensure that the resource generates the expected services and units for the society. The status of the resource and its units is the feedback based on which actors take further action.



**Figure 0-3. Conceptual model - animating one action situation**

The conceptual model represents multiples interactions of one action situation with respect to two levels. At operational level, actors work on the lake to produce certain values and the status of the values give the feedback to the actors about the value and the lake. At collective choice level, actors are involved with each other and in designing the rules at operational level. Actors use the feedbacks from the bio-physical aspects of the lakes and the achieved value to re-design the rules and their actions. Periodically with feedbacks from the operational level, redesigning at collective choice and constitutional level may also occur (not shown in the figure). To analyse the interactions, the sub-variables that are contained within the main tiers are identified. The selection of sub-variables is based on the assumption that specific governance system (here collective action) is driven by the value/s generated or the



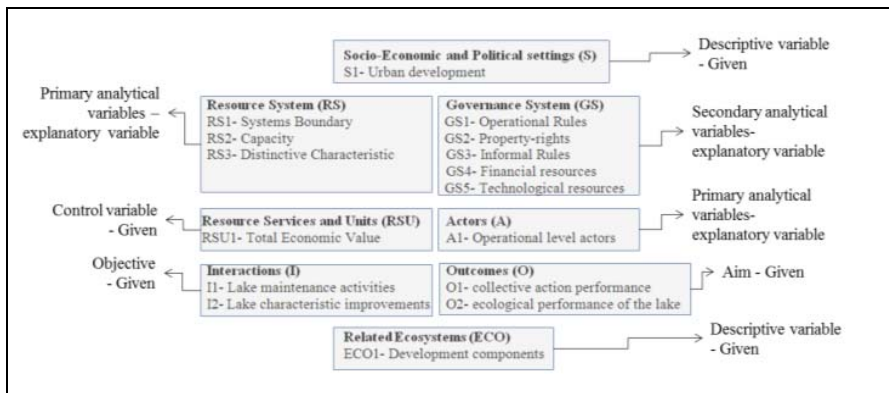
value/s expected from lake system. They are derived and adapted from the available list from Ostrom, 2009 and presented in table 1.

**Table 1. Sub-variables of the SES framework for Mansagar Lake**

<b>Socio-Economic and Political settings (S)</b>	
S1- Urban development	
<b>Resource System (RS)</b>	<b>Governance System (GS)</b>
RS1- Systems Boundary	GS1- Operational Rules
RS2- Capacity	GS2- Property-rights
RS3- Distinctive Characteristic	GS3- Financial resources
	GS4- Technological resources
<b>Resource Services and Units (RSU)</b>	<b>Actors (A)</b>
RSU1- Total Economic Value	A1- Government organisations
	A2- Non-Government organisations
	A3- Individuals
<b>Interactions (I)</b>	<b>Outcomes (O)</b>
I1- Lake maintenance activities	O1- collective action performance
I2- Lake characteristic improvements	O2- ecological performance of the lake
<b>Related Ecosystems (ECO)</b>	
ECO1- Development components	

Source: Adapted from Ostrom, 2009

The actors taking or not taking actions to maintain the values are the primary analytical variables. The resource system is the secondary analytical variable and characterizes the physical-ecological aspects of the lake. The governance systems are the higher order secondary variables and important in explaining (in some research predicting) why certain outcomes (sustaining certain values) are reached or not (Ostrom, 1986). The resource services and units characterized by the TEV is the control variable and descriptive in nature. The actors, governance system and resource system are explanatory variables. Different units of analyses and sources are used to analyze them. The socio-economic and political settings and the related ecosystems are the descriptive contextual variables. With this analogy, the observed (one) action situation is presented as a building block in figure 4.



**Figure 0-4. Position of the variables in the observed action situation**

## 5. DATA COLLECTION

The fieldwork is done in multiple periods to capture the monsoon, pre monsoon and post monsoon conditions of Mansagar Lake. The fieldwork included simultaneous field observations and documentation of the Mansagar environs and questionnaire survey of the officials and the local people. The first visit involved pilot surveys of the

questionnaires and participation in the 15<sup>th</sup> Annual Birding Fair held at Mansagar ([www.birdfair.org](http://www.birdfair.org)). The participation gave a start to visit to the lake site and networking with the local people. The in-depth structured interviews with the officials are conducted during this visit. The second visit involved interactions with the local people and officials focussing on the Rajasthan High Court's order on collective action towards Mansagar maintenance. The visit also involved preparing for the questionnaire survey of the local people. The third visit involved questionnaire survey of the local people living and working in the Mansagar surroundings.

The primary actors of collective action situation are predetermined. To identify the collective action situation, the organizations collectively involved in Mansagar lake maintenance activities are the primary organisations for analysis. The organisations together formed the Empowered Committee on Infrastructure Development (ECID). Other organisations that are associated with the ECID organisations and have a role to play in the maintenance of Mansagar are also identified. They are called secondary (and tertiary) organisations in the collective action situation. Twenty two officials are generally interviewed from these organizations. The list of officials was built with the visit to the lake site and with the interviews using the snow-ball sampling technique. The respondents from the ECID organizations are the top-ranked officials who have decision making powers in Mansagar lake maintenance activities. They are assisted by other official/s having technical know-how of Mansagar maintenance. The table 2 presents the list of officials from the ECID organisations. Each questionnaire is thus responded by a small group of people, making the responses more representative of the organisation.

**Table 2. Profile of the Organizations and Respondents (officials)**

<b>ECID Organizations</b>	<b>Representative Official/ Position</b>
- Principal Secretary, UDH, Govt. of Raj.	H N Rathi, Head, RUIDP
- Principal Secretary – Tourism, Govt. of Raj.	Mr. Gunnidhi, Director
- Jaipur Nagar Nigam (called JMC) through Chief Executive Officer	Loknath Singh; S L Sharma
- Jaipur Development Authority (JDA) through Commissioner.	Vishal Jain, Commissioner
- District Collector (DC), Jaipur	Navin Maharaj
- Jal Mahal Resorts Private Ltd. (JMRPL)	Rajeev Lunkad, Director; Lokesh Mansukhani
- PDCOR Ltd., Jaipur	Ashish Dua
- State of Rajasthan, through Chief Secretary,	G S Sandhu

To analyse the ecological performance of the lake, the respondents selected are the local people who live and work in the Mansagar environs. The respondents are selected from an area of 200 meters width around the Mansagar shores (figure 1). The tourists are excluded from the survey since they do not qualify as people who have experienced the developments in the lake and its environs over certain period of time. A total of hundred and fifty local people responded to the questionnaire survey. The respondents mainly consist of employers and employees in private businesses (103 out of 150) of formal and informal shops; government employees (13); retired personnel (12); student (12) and others (10). The respondents belong to diverse ethnic and economic backgrounds. The respondents mainly consist of those who visit Mansagar atleast once a day (87 out of 150). The purposes of visit by such respondents are primarily work, fitness, and spirituality. Other respondents consist of those who visit Mansagar once a week (32 out of 150) or once a month (20 out of 150). They are mostly those living in the vicinity. The purpose of their visit is primarily recreation and psychological.

The SES sub-variables are the higher order analytical variables as they guide the characteristic of the analysis. The other instruments go hand in hand with the source of data and the multiple units of analysis such as,

- Reports and documents of projects and planning pertaining to the maintenance of Mansagar, such as work books, ecological and limnological characteristic records, administrative records, evaluation studies, news from the media.
- In-depth and structured interviews with the officials from the ECID organizations. The interview is structured using a questionnaire focusing on the performance of collective action of the involved organizations and ecological condition of the lake. The officials are the proxy units of analysis for organisations. The limitation in doing so is: individual's (official) views may or may not be in alignment with the organization's ideology and objective. With organizations' objective explicit in the general reports, the views of the officials are additional information.
- Primary observations and documentation of the Mansagar Lake and its environs particularly focusing on the physical aspects of the land mass, water quantity and water quality. They are in the form of notes, photographs and few video recordings. Observations and documentation are used as anecdotes and photographs in the analysis. An important aspect of the visit to the lake site was tracing of the inlet and outlet drainage channels. It helped to get many surprising facts linked to the ecological aspects of Mansagar and to map the involved organizations, which otherwise seem difficult.
- Questionnaire survey of the local people living and working in the vicinity of Mansagar Lake. The questionnaire is structured focusing on ecological condition of the lake and the performance of the organization pertaining to the maintenance of the land mass, water quantity and water quality. The perception of the local people on the lake and the organizations are used as a proxy to measure the ecological performance of the lake and the performance of the organizations involved in the maintenance. Important to note that the local people are not in a position to assess the collective action.

There are two questionnaires designed for two different groups of respondents. The questions are derived from the sub-variables of the SES framework. The type of questions is mixed: multiple choices and qualitative-descriptive. The qualitative questions involve description of a scenario/event/situation. There are two types of multiple choice questions: selecting one option from the given choices such as high, medium, low, don't know; and selecting one or more options from the given choices.

The questionnaire to analyse collective action performance is composed of:

- Introduction to the research and researcher;
- General inquiries;
- Information on the current collective efforts;
- Information on the current collective efforts towards lake maintenance activities;
- Information on the ecological characteristics of the lake; and
- Suggestions and feedbacks.

The questionnaire to analyze ecological performance of Mansagar is composed of:

- Introduction to the research and researcher and eligibility of the respondent;
- General inquiries;

- The sustainability (physical-ecological) aspects of Mansagar;
- Ongoing lake maintenance activities;
- Efforts of the organizations towards Mansagar lake maintenance activities; and
- People's contribution towards the Mansagar lake maintenance.

## 6. ANALYZING MANSAGAR LAKE GOVERNANCE

In the following the sub-variables of the SES framework guide the analysis. It starts with the contextual variables and moves to the focal action situation and ends with the interactions and outcomes linked to the performance of the collective action and ecological performance of Mansagar. The analytical approach is strategic with the selection of research methodology and research design. The data collected is qualitative and so is the analysis. The analysis is primarily descriptive and explanatory in nature. The research question one involves description of the network of actors in collective action situation and explanation of the characteristics of collective action amongst the actors and linked to the ecological condition of Mansagar. The characteristics are qualitatively analyzed from the responses of the officials involved in the questionnaire interviews. The research question two involves description as well as explanation of the ecological condition of the Mansagar. It is qualitatively measured from the questionnaire survey of the local people who live and work in the vicinity of Mansagar and are acquainted with the ongoing lake maintenance activities.

### 6.1. Socio-Economic and Political settings (S)

#### S1- Urban Development

Jaipur, known as the “Pink City”, is a famous tourist city and the state capital of Rajasthan in India. The tourist triangle of Delhi, Agra and Jaipur is most visited by people from across the world. About 800,000 tourists visit Jaipur every year. It is known for its palaces and forts and its rich arts, crafts and culture. Its proximity to Delhi also brings many businesses into the city. It is known for silver and diamond jewellery and dying of clothes. The economy of the city is primarily linked with the tourism activities.

Mansagar Lake is situated at the north end of the Jaipur city limits on the Jaipur-Amber Fort-Nahargarh Fort tourist corridor (figure 5.). It was planned in the late 16<sup>th</sup> century under the decision of the then ruler to overcome a famine period in the region. Mansagar was never a tourist destination unlike what is promoted in the recent restoration activities. Mansagar is the only significant water body in Jaipur since the others *Katora Taal* (tank) and *Sukha Nala* (dry drain) are heavily suffering from deterioration.

Jaipur's urban population is over 3 million now and a density of over 3000 people per sq.kms. The spatial development of the city has sprawled to the south and west shore of Mansagar, and is a cause of major stress on the lake system. More than 50,000 people are estimated to live in the catchment of Mansagar and another 25,000 people pass through or visit the lake every day.

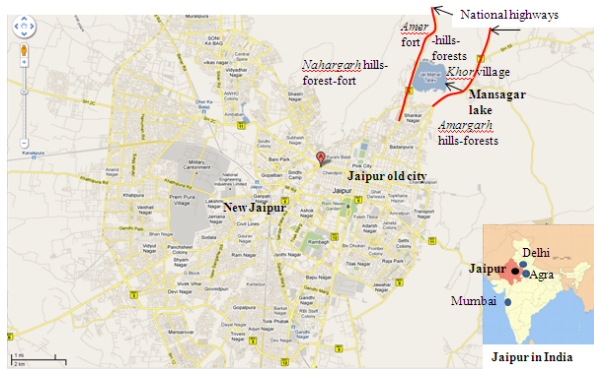


Figure 0-5. Jaipur in India and Mansagar in Jaipur

## 6.2. Actors

Actor identification is crucial to governance studies and while building the SES framework. A comprehensive classification of actors in polycentric governance in Indian wetlands is presented in the by Narayanan and Venot (2009). The complexity of actor identification arises from the fact that the actors belonging to different levels act at the operation level. Actors are grouped into the following categories and are discussed below:

### **A1- Government organisations**

- A1.1- Political party leaders
- A1.2- Local government organizations
- A1.3- State government organizations
- A1.4- National government organizations
- A1.5- Semi-government organizations
- A1.6- Judiciary

### **A3- Individuals**

- A3.1- Direct Users (Local People)
- A3.2- Visitors- local and outsiders

### **A2- Non-Government organisations**

- A2.1- Civil society organisations
- A2.2- Private entrepreneurs
- A2.3- Consultants
- A2.4- Media
- A2.5- Academic organisation
- A2.6- Research organisation
- A2.7- Execution organisation
- A2.8- International organizations

### **A1- Government org., A2- Non-Government org., and A3- Individuals**

During the past, several attempts of the Government of Rajasthan (GoR) to restore the ecological condition of Mansagar and its precinct did not yield positive results because of paucity of funds and non-incentivised approach to take up restoration. The current restoration of Mansagar was conceptualised in the political sphere in 2000 with the then Chief Minister of Rajasthan Ashok Gehlot wanting to restore the ecology of Mansagar Lake for tourism. The GoR appointed the Infrastructure and Finance Services (IL&FS), Delhi to find solutions to Mansagar restoration. The Jaipur Development Authority (JDA), Jaipur Municipal Corporation (JMC) along with consulting organisation PDCOR Limited prepared a project proposal on Mansagar Restoration Project (PDCOR, 2001) and submitted it to the Ministry of Environment and Forest (MoEF), Government of India.

A bidding process was initiated to invite private sectors to invest in the Mansagar with incentives of developing the newly reclaimed land for tourism. The bidding process was coordinated by PDCOR and a technical evaluation committee (box 1) was formed to oversee selection of the bidder. The Jal Mahal Resorts Private Ltd.

(JMRPL), a Mumbai based private organization was assigned the project with an arrangement of developing the newly reclaimed land for tourism on a lease for ninety nine years. The annual lease amount of INR 25 million is set with periodical revision every three years. Besides, the *Jal Mahal* is leased for restoration and maintenance. Realizing the problem of multi-ownership during the inception of Mansagar restoration project, the Tourism and Urban Development and Housing (UDH) Ministries of GoR along with the JDA, JMC and others collectively decided to form a committee to implement and monitor the restoration activities. The committee is named as the Empowered Committee on Infrastructure Development (ECID). The ECID is comprised of different government organizations (box 1). The Rajasthan Tourism Development Corporation (RTDC) is the nodal organisation and in-charge of lake tourism and the JDA is in-charge of the development and maintenance of the lake promenade. The project is named as *Jal mahal* Tourism Development (JMTD) and the empowered committee is known as *Jal mahal* Tourism Development Corporation Limited (JMTDCL). Advocate Jain (2010) through High Court case petitions shows concern that a ecologically sensitive project is assigned to a private organization that has no experience in ecological restoration projects. He also alleges involvement of politics and corruption in the bidding and project assignment.

**Box 1. Collective action example: Different Committees for Mansagar Lake Restoration**

**A technical evaluation committee (TEC) to oversee the selection from the bidders of Mansagar Lake Restoration:**

- |   |          |
|---|----------|
| 1. Managing Director, RTDC                        | Chairman |
| 2. Executive Director, RTDC                       | Member   |
| 3. Chief Town Planner, GoR                        | Member   |
| 4. Executive Director (Finance), RTDC             | Member   |
| 5. Mr. B.V. Doshi, Leading Architect, Ahmedabad   | Member   |
| 6. Mr. Mohd. Shaher, Leading Architect, New Delhi | Member   |
| 7. Chief Executive Office, PDCOR                  | Member   |
| 8. Representative IL & FS Limited                 | Member   |

**Empowered Committee on Infrastructure Development (ECID) to overlook Mansagar restoration:**

1. State of Rajasthan, through Chief Secretary, Secretariat, Jaipur
2. Principal Secretary, UDH, Govt. of Rajasthan, Secretariat, Jaipur
3. Principal Secretary - Tourism, Govt. of Rajasthan, Secretariat, Jaipur
4. Jaipur Nagar Nigam through Chief Executive Officer, Lal Kothi, Jaipur
5. Jaipur Development Authority through Commissioner, JLN Marg, Jaipur
6. District Collector, Jaipur
7. Jal Mahal Resources Pvt. Ltd., through its Director Shri Nav Ratan Kothari, C-Scheme, Jaipur
8. PDCOR Ltd., CEO, Laxmi Complex, M.I. Road, Jaipur

Since the project approval, the government organisations like JDA and JMC and the private organisation like JMRPL are engaged in Mansagar restoration activities with specific roles in the collective action situation. JDA and JMC are involved in the waste water issues and the promenade maintenance. JMRPL has set up an office on the new reclamation land and are involved in the development of the Tourism Master Plan. While they struggle to acquire approvals due to legal interventions, they also struggle to maintain the lake water quality. The works are outsourced to several local private organisations. The roles and actions of various organisations and individuals are discussed while discussing the other variables. The local people and visitors play negligible role in the operation and maintenance activities. They are affected and they affect the lake by their use pattern.

From the source of the sewerage/ rain water in the upstream catchment areas to the treatment plants and further to the lakes and to the downstream, several

organizations collectively work to ensure water quantity and quality into the lakes. Figure 6 presents a simulation of the water flow into the Mansagar and the organizations that collectively work to ensure the water quantity and quality in Mansagar. Officials claim that on one hand integration of activities called for collective action among the various organizations, but on the other hand there are several challenges in coordination because the priorities of the organizations differ with space, time, resource (financial, human, technical, physical) availability.

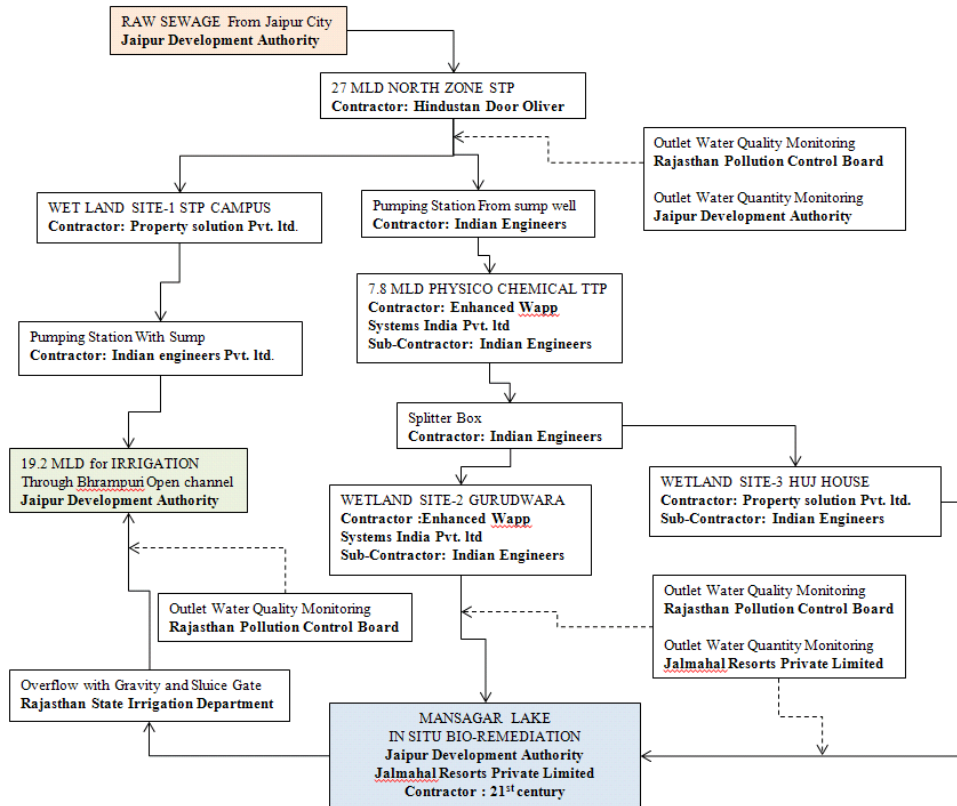


Figure 0-6. Organizations involved in collective action to ensure water into Mansagar

In a collective action situation, action of each actor is linked to the actions of other actors and together they are linked to the performance of the lake. It was found that poor maintenance of the sewerage treatment plants negatively impacted on the trust and reciprocity of actions amongst the actors and to the poor quality of lake water.

### 6.3. Governance System (GS)

#### GS1- Operational Rules

There is abundance of Policies, Acts, Rules and Laws in the Water Resources, Environment, Forest, Agriculture, Fisheries and Social sectors that are directly or indirectly related to lake maintenance (Reddy and Char, 2006). Several acts and notifications issued by the Ministry of Environment and Forests (MoEF) provide the legal framework for protection of lakes and reservoirs (wetlands) which deal with the environmental protection, pollution control, specific natural resources protection acts, and hazardous waste management. A grant of INR 247.2 million was sanctioned by MoEF for Mansagar restoration under the National Lake Conservation Program

(NLCP) in 2002 with 70:30 shares of MoEF and JDA and with JDA as nodal organization for lake restoration (MoEF, 2008). With this arrangement, JDA developed the Chaupati, lake drive road, waste water treatment plants at the inlet of Mansagar and reclaimed a portion of land from the lake.

The Bombay Land Revenue Code declares all lakes and tanks which are not individually owned, to be the properties of the Government. The High Court has made it clear that, the State is the trustee of all natural resources meant for public use, including lakes and ponds and is under a legal duty to protect them. The natural resources should not be sold for any private interest. The directive principles of the Indian Constitution Article 48-A outlines that the government is the trustee of all natural resources and shall protect and improve environment to safeguard the lakes, rivers, forests and wild life of the country; and Article 51-A (g) outlines that it is the fundamental duty of every citizen of India to protect and improve the natural environment, including forests, lakes, rivers and wild life, and to have compassion for living creatures (Reddy and Char, 2006). Interestingly, it is found in almost every document on environment. Whether it impacts the behavior of people is questionable and such constitutional principles are arguable.

The Water (Prevention, and control of pollution) Act, 1974 covers all changes in physical, chemical and biological properties of water; and seeks to prevent and control water pollution and maintain and restore the wholesomeness of water with the abatement of water pollution. The Water Board may ask relevant information concerning discharge of effluent or sewerage. But, no power is given to the Board to stop pollution or impart directions in cases of pollution. The Central Pollution Control Board have set effluent discharge standards for waste water (CPCB, ....). The State Pollution Control Board (SPCB) is the monitoring organization representing CPCB. One, the implementation of the standards is far from reality. Experts attribute this to lack of proper mechanism for fines and taxes on polluters. The monitoring organizations do not have powers to impose fines/taxes. Three, imposing fines/taxes is complicated since many polluters are government organizations.

Legal battles are ongoing including several public interest litigations (PIL) filed and addressed in the High Court (HC) of Rajasthan by civil society organizations (CSOs) such as 'Dharohar Bachhao Samiti' (heritage conservation group) against the ecological restoration project of Mansagar Lake. The PILs are diverse ranging from the land reclamation issue, the idea of tourism development on the lake, lease of *Jal mahal*, boating lease, waste water inflow into the lake, the wetland and sedimentation tanks, outflow of the waste water to the downstream village. The Right to Information (RTI) is the main source of information for the CSOs. According to government officials, the CSOs collect information from the government organisations and later based on the information they file the PILs. They complain that court appearances consume lot of their productive time and hence there should be some professional way to address PIL hearings. The CSO officials claim that the information should be made public anyway and if not, then the RTI forces the government organisations to organise the public information and share with people.

Under the JMTD, the responsibilities are distributed. The JMRPL is primarily involved in maintaining the lake ecosystem. The JDA and JMC are assigned supporting Mansagar restoration through maintaining the secondary treatment plant (STP) and



the tertiary treatment plant (TTP), whose waste water flows into the lake. JDA is also assigned maintenance of the newly developed lake promenade. JDA and JMC have outsourced the operation and maintenance activities to private organisations such as M/s Hindustan Door Oliver Limited and Enhanced WAPP Systems Private Limited.

## **GS2- Property-rights**

The ownership of Mansagar and *Jal Mahal* remained with the royal family of Jaipur until the independence of India in 1947; after which according to the Indian Constitution then, the lake being designated as water body for public purposes was transferred to several government organizations based on the different component comprising the lake system such as land, water, dam, fishing, drainage channels, forest etc. The land belonged to the District Collector (DC) of Jaipur after it was transferred from the royal family; the drainage channels, water and the dam was with the State Irrigation Department; the fishing control was with the State Fisheries Department, the forests was with the State forest Department and etc. Experts trace this time as the beginning of the downfall of Mansagar, for example, after independence until 2000 negligible restoration work happened amidst the battle of ownership between the royal family and different government organizations; and more so because of unclear assignment of responsibility among government organizations regarding lake maintenance.

Further deterioration of Mansagar started in 1962 when JMC decided to divert the walled city's sewerage water into Mansagar through two main wastewater drains from *Brahampuri* and *Nagtalai* which still continue to happen. It is unclear how JMC undertook this decision particularly, if the DC was the official owner of Mansagar. After JDA was formed in 1982 under the State Department of Urban Development and Housing (UDH), JDA became in-charge of maintenance of Mansagar with the ownership remaining with the DC.

*Jal Mahal* has been in the ownership contention since it was taken over from the royal family. In 1968, *Jal Mahal* was declared as protected monument site (u/s 3 of the Rajasthan Monument Archeology site and Antiquities Act) and the ownership shifted to the Archaeological Survey of India. Later, it was declined in the year 1971. Since then the ownership of *Jal Mahal* is with the Ministry of Tourism, GoR, whose local representative is the RTDC.

The JMTD project streamlined the property rights and brought the lake rights under the JMTDCL. Now Mansagar and *Jal mahal* are under the RTDC after the formation of JMTDCL. Hundred acres of reclaimed land are leased for ninety nine years to the JMRPL with additional responsibility of Mansagar maintenance. So the official trusteeship of the lake is currently with the JMRPL. According to Advocate Ajay Jain, the 100 acres land leased for development to the JMRPL by JMTDCL is part of the lake submergence for which ninety nine years lease practically means selling the property and is constitutionally illegal. Some CSOs are concerned about the privatization of the public land, particularly a lake land that is ecologically sensitive. They have lodged legal case against JMTDCL and the entire JMTD project over this issue. Advocate Jain (2010) who is involved in couple of cases as the complainants' lawyer attributes the act of reclamation as a cause of the shrinking of the lake area.

### GS3- Financial resources

The ecological restoration project of Mansagar sanctioned through the NLCP under the MoEF was estimated at INR 247.2 million; the 70% of which is contributed by the MoEF and the balance 30% was supposedly borne by JDA. The JDA was the local recipient of the funds. Important to mention here is that JDA is the first organization in the country to design the 'land bank' system for acquiring lands for urban development such as the Land Bank under new Hotel Policy, 2006. CSOs show concern that the 30% fund that the JDA was supposed to contribute in the Mansagar restoration, was actually generated by the reclamation of the 100 acre land which is eventually leased out to JMRPL. Experts add that similar approaches are the modus operandi in most urban lake development initiatives across India.

There are debates on the way the money is spent. Under the project, the realignment of *Brahmapuri nala* and de-silting of lake is done. The silt obtained is used for widening of main Amber road, construction of check dam in 200.0 m length at the forest valley in the north side, development of three islands, and development of lake front promenade in 1.0 km. length along Amber road and tourist trail of 2.70 kms. length from Amber road to Mansagar Dam on the north side. The afforestation of the hills in the lake catchment was done through Forest Department.

The 100 acres land leased to the JMRPL generates an annual sum of INR 25 million which is deposited with the JMTDCL (i.e. RTDC). The sum is supposedly meant for the lake maintenance and is deposited as an escrow<sup>3</sup> account of the committee. To spend it for lake maintenance, the sum needs to be transferred by RTDC to the JDA/JMC. Unfortunately, the fund has not started rolling even after five years of fund deposition. There is a kind of tension between RTDC, JDA/JMC and JMRPL. On one hand, RTDC official remark that JDA is not fulfilling the conditions to receive the funds and on the other hand, JDA official remark that RTDC is not willing to disburse the funds. The JMRPL officials complain that the funds are not utilized for lake maintenance and it is resulting in additional cost on JMRPL for lake maintenance since they are involved in actual implementation on the lake site.

### GS4- Technological resources

Officially, the lake water level is maintained by supply of 7.0 million litres per day (MLD) treated waste water from the secondary treatment plant (STP) after removal of nutrients through the tertiary treatment plant (TTP). The TTP is a 7.8 MLD physico-chemical treatment plant (PCTP). The waste water of PCTP is treated further through reed bed treatment designed by German specialist Herald Kraft (according to JMRPL official). Finally, the wastewater finds its way to the artificial wetland developed in 4 hectares of the lake at the inlet of *Brahmapuri nala* before it becomes part of the lake water. A broad overview of the water collection in Mansagar is presented in figure 7. The in-situ bio-remediation for improving the lake water quality is in progress. Officially, in this process 140 diffusers & 5 compressors air are planted in the lake bed for aeration & inversion of lake water and bio-mass.

<sup>3</sup> escrow is an arrangement made under contractual provisions between transacting parties, whereby an independent trusted third party receives and disburses money and/or documents for the transacting parties, with the timing of such disbursement by the third party dependent on the fulfillment of contractually-agreed conditions by the transacting parties.

During the primary field visit to the lake, one of the engineers involved in the operation of them casually remarked that less than half and only one compressor are functioning because of the lack of maintenance since their execution.



Figure 0-7. Sequence of waste water treatment and inflow from Brahmapuri nala into Mansagar Lake

## 6.4. Related Ecosystem (ECO)

### ECO1- Development Components

Tourism in the city has attracted several residential, hotel and commercial developments in the lake surroundings particularly in the south and west. Many of these developments still lack proper infrastructure including drainage and sewerage. Most building premises have constructed tube wells to extract water from the ground for their private purposes resulting in very high rate of ground water depletion.

Two highways from the south-east and west of Mansagar have delineated the lake into new and reduced area. The highways have blocked the surface runoff from the hills and flow of the water into the lake. Meanwhile, the deforestation of *Amer*, *Amargarh* and *Nahargarh* hills for urban development and forest extracts result in fast runoff and soil erosions from the hills during monsoon and brings heavy silts into the lake bed. Squatting on the lake shore also happened in the past in two ways: residential and religious. Several religious and residential buildings squatted in the south of then lake bed during the partition of India and Pakistan in 1947. Experts believe that the squatting of religious buildings have strong relation with the lake because of access to water which was open in the past.

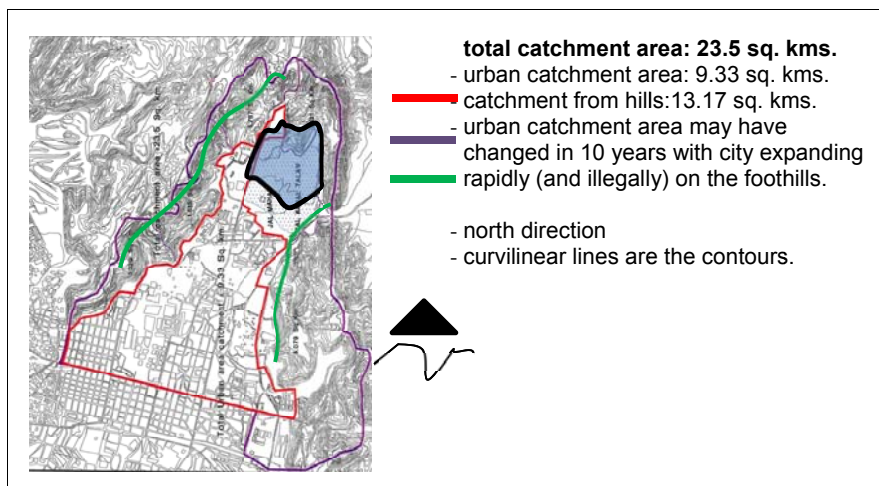
While the city's waste water flowing through the *Brahampuri nala* is officially treated and discharged into Mansagar, the *Nagtalai* nala continues as an untreated drain. The waste waters from these nalas are diverted from Mansagar to the downstream village area. The unpredictable monsoon pattern in the last few decades has also affected the water holdings in the lake. Water holding and outflow to the downstream irrigation systems is a continuing tension between the downstream villagers of Khor and the local government. The tension fluctuates with the change of season, even though the nature of lake water has changed to waste water, for example, during monsoon the excess water flow from the lake increases the risk of flooding in the downstream village and during summer the water holding in lake increases the demand of water from the downstream village. Since the downstream area do not fall under the restoration plan, the organizations involved in JMTD don't have answers to it. There is outrage in the people of the downstream over the waste water issue.

## 6.5. Resource Systems (RS)

### RS1- Systems Boundary

On one hand, it is crucial to delineate a boundary of a lake system and on the other hand, it is a challenge to delineate a boundary to a lake system. A lake system is composed of catchment area, inflow/inlet drainage channel, lake edge (inlet and outlet shorelines), lake bed, surface water, ground water and overflow/outlet drainage channel and finally to the lake bio-diversity (Schuler and Simpson, 2001). In addition, it is crucial to consider other physical aspects in lake system studies, such as physiographic profile of the lake system, the size, the water quantity and quality, surface water or ground water condition. It is important to study the elemental parts in order to get comprehensive understanding of a lake system. The study of land and water of a lake system is referred as watershed and is crucial to lake sustainability.

The Mansagar watershed (figure 8) is composed of a catchment area of approximately 23.5 sq. kms. and comprises of the water shed, inflow/inlet drainage channel, lake edge (inlet and outlet shorelines), surface water flow, ground water and overflow/outlet drainage channel and the other developments in the catchment area. The catchment area consists of 40% urbanized in the south, hilly forest in the north, partly forest and urban development on the hills in the west. The overflow/outlet drainage channel area was designed through the dam and now is through a channel adjacent to the dam.



**Figure 0-8. The catchment of Mansagar lake system**

Source: PDCOR, 2001

## RS2- Capacity

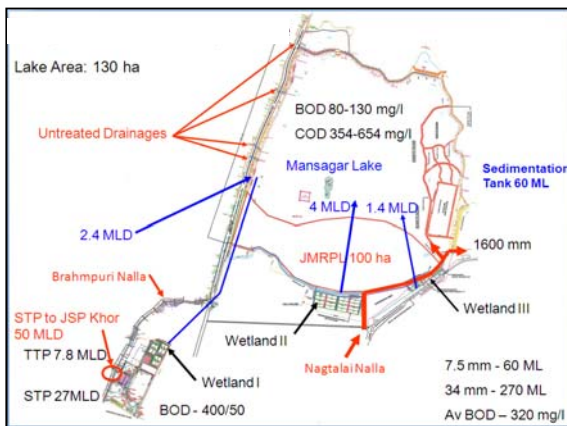
In its full tank level, the current capacity of Mansagar is over 2.5 mcm. (million cubic meters). Before 2000 for few decades it was difficult to sustain rain water in the lake for whole year owing to scarce and periodic rains and highly permeable soil increasing the probability of percolation of water into the ground. Now since the waste water flows regularly into the lake and since lot of silt is deposited in the lake bed, the percolation from the lake has reduced resulting in availability of water in the lake for whole year.

## RS3- Distinctive Characteristics

The main source of water in the lake is the treated and untreated sewerage water from the Jaipur city. Officially, sewerage water is treated at secondary and tertiary-level (JDA, 2010; JMRPL, 2010). The STP and TTP is located on the *Brahmapuri nala* whereas, *Nagtalai nala* is a polluted open drain. The irony of the STP and TTP are: the capacity of STP and TTP are 27 and 7.8 million litres per day (MLD) whereas the everyday load from Jaipur city is around 50 MLD. It was found during the fieldvisit and confirmed by some plant engineers that the sedimentation tanks at the STP and TTP site are not properly functioning. In addition, the untreated waste water from the dying industries and the surrounding developments mix with the treated waste water in *Brahmapuri nala* during its flow towards Mansagar.

The residential, commercial and hotel development in the vicinity are not covered in the city’s main sewerage system because of dispute over infrastructure provision responsibility between JDA and JMC resulting in waste water discharge from these developments. The waste water continues to flow from these areas into Mansagar polluting the lake bed and the ground water.

Once a source of drinking water, the water quality is now far below the healthy water standards. In addition, the actual waste water quality is below the set standards for waste water (RSPCB, 2010). The total waste water scenario is presented in figure 9. The environmental audit report prepared by RPCB (2010) shows that the ongoing efforts to treat lake water are not sufficient. A physico-chemical analysis of the water sample collected from the centre of the lake in the pre-monsoon period over a period of 2000-2010 is presented in table 3.



**Figure 0-9. Inflows into Mansagar**

Source: various sources

**Table 3. Physico-chemical analysis of the Mansagar water**

Parameter	Standard	2000	2003	2005	2006	2007	2008	2009	2010
pH	6.5-8.5	8	8.2	8.65	7.73	7.4	6.8	8.97	9.26
Initial D.O.		-	-	-	6.8		0.7	5.6	10.9
B.O.D.	< 3	60(F)	-	390(UF)	137(UF)	30(F)	28(F)	16(F)	88
C.O.D	0.5	231.44	-	360(UF)	186(UF)	112(F)	107(F)	128(F)	398
Chloride (Cl)	-	390	-	216	324	-	-	-	1090
Sulphate (SO <sub>4</sub> <sup>2-</sup> )	-	35	-	-	1544	-	-	-	271.11
Phosphate (PO <sub>4</sub> )	0.03	5.25	12.4	9.6	5.8	15	2.2	-	3.6
Nitrite (NO <sub>2</sub> )	-	36	-	-	-	-	-	-	0.0513
Nitrate (NO <sub>3</sub> )	0.3	-	-	1.0	3.4	10	6	30.33	-
Kjeldahl Nitrogen	-	-	52	102	86.24	23	-	-	5.32
Total Solids	-	-	-	-	-	-	-	-	-
Total Dissolved	400	1840	-	1.5	-	-	-	-	2548

<b>Solids</b>									
<b>Total suspended solids</b>	-	260	-	-	-	85	90	116	450
<b>Oil and grease</b>	-	Nil	-	-	-	-	1	-	

Source: various sources

Comparing with standards and what was in 2000, the analysis of 2010 are concerning, for example, the pH value is now 9.26, where the standard is between 6.5-8.5; the BOD is almost 30 times more than standard (>3) at 88; the COD is just unacceptable as per the standards; and the total dissolved solid is higher by six times than standard (400) at 2548. Experts call for immediate remedial measures. Gupta (2012) suggests that the rain water run-off should not be allowed to enter into the lake in any case as the water is highly polluted with organic material. There are about 75 industries in the nearby areas of Mansagar Lake which are discharging their waste in *Brahmpuri nala* without any treatment, out of which 24 industries have are identified as defiant of the polluted and waste water rule (RSPCB, 2010).

In 2007, JDA realigned the drains and channeled the excess sewerage downstream. Environmentalists show concern that it has affected the farming pattern and the health of people of the downstream. Biological process like reed-bed treatment is applied on the *Brahmapuri nala* at the inlet of the lake. A sedimentation tank is also built to hold the water before releasing into the wetland which is meant for further and natural purification of the waste water entering the lake. While the sedimentation tank is designed for a maximum BOD of 5 mg/L, Gupta (2012) found in his study found that the storm water run-off (even from the tenth rain) possess BOD greater than 100 mg/L. He believes that the storm water run-off entering the lake is a big source of lake pollution. Some environmentalists argue that the idea of sedimentation tank requires frequent dredging which is doubtful based on the past records. Experts show concern over segregation of a portion of the lake with settling basin. He even remarked that it may be a business plan that requires the perpetual cost of dredging. As per Sharma (2008), the sedimentation tank is less effective and proper treatment techniques should be used at the mouth of inlet.

Three Artificial wetlands are developed for natural replenishment of the treated waste water before it mixes to the lake water. Experts suggests installation of a sewerage treatment plant near the overflow of Mansagar, so that the excessive waste water can be treated and then be reused for irrigation practices in the downstream. He made two important remarks: the NLCP itself has not provided for any clear benchmark of water quality or any other characteristic that should be achieved in lake restoration; and the wetland and sedimentation tank if not dredged frequently may turned into a piece of land with silt deposits over 10-20 years, which is commonly seen in most urban lakes in India. Although records don't say, but according to JMRPL officials, the water quality has improved in the last four years.

Three earthen islands are developed for improving the bio-diversity in the lake and also improve the natural replenishment capability of the lake. These islands are conceptualized as breeding-centers for resident and visiting bird species. Acacia, wild grass and shrubs are planted on these islands. Vardhan (2010) commented that proper vegetation is essential on the islands as well as in the lake to restore the lake biodiversity. Over 180 bird species are cited in the Mansagar lake environs. He appreciates the restoration efforts with respect to increase in bird population in last 5

years. Within the restoration project, the Forest Department planted many trees on the hills slopes that are surrounding the lake. Over 110 trees and shrub species are found in the three hilly ranges of Mansagar.

Finally, with the new restoration plan, Mansagar witnesses further reduction in the land area and therefore its water holding capacity. The land of the lake involves complex land governance mechanism and political interest since land is a precious resource for real-estate development. One of the experts cynically remarked, that lake is non-salable whereas land is salable and therefore there is more interest on land management than lake management among the officials. The JMTD project can be viewed from the land dynamics angle as discussed above. Interestingly, when there are concerns over 100 acre land reclamation by the JDA and its lease to the JMRPL, the land reclamation in the north of Mansagar resulting out of the new lake drive road leading to the dam goes unnoticed. Experts say that it is because there is no private organization involved. This land is also likely to turn into developable land in some years owing to the deposition of silts flowing from the mountains and settling over the unintended sedimentation tank. A simulation of delineation of Mansagar since its inception until today is presented in figure 10.

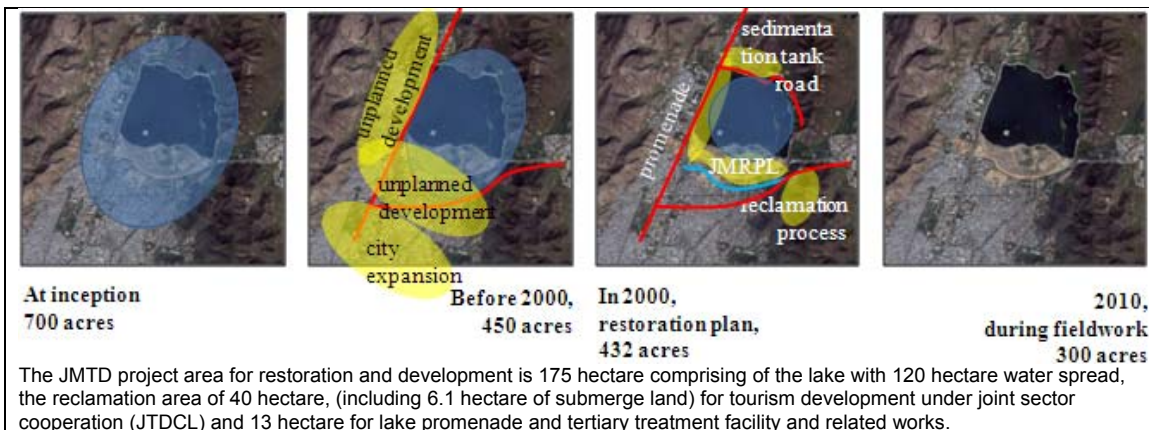


Figure 0-10. Simulation of Land dynamics in Mansagar over time

## 6.6. Resource Services and Units (RSU)

### RSU1- Total Economic Value

The Total Economic Value (TEV) refers to the 'type of use' and is composed of: direct use value, indirect use value, option value, bequest value, intrinsic value (Pearce and Moran, 1994). These value categories value may be of social, political, economic, ecological, cultural and/or engineering importance to the society as represented in the matrix of values in table 4. The different value generation attributes to the polycentricity and collective action such as the case of Mansagar restoration initiative. The stated and the preferred *value* as used in the valuation studies (Kontoleon, 2002) refer to the preferences/choices made and expressed by the society. The stated and preferred value of Mansagar identified are: bio-diversity (fauna and flora); aesthetic; historic; irrigation water; land development; public open space; recreation; tourism; wastewater sink. They are simulated in the matrix of value in the value. The value such as drinking water and fishing though absent are also identified. Each value generates adjacent action situations.

Table 4. Matrix of Value

Type of use → Importance ↓	direct use value	indirect use value	option value	bequest value	intrinsic value
social	R, T, A, POS	BD,	BD,		
political	POS	IW,		BD POS, R, T,	POS
economical	LD	IW,	LD	LD	
ecological			BD,	BD,	BD,
cultural	A, F,		LD	LD	
engineering		IW			
<b>Values identified in Mansagar: *not active</b>					
aesthetic	<b>-A</b>	historic	<b>-H</b>	public open space	<b>-POS</b>
bio-diversity	<b>-BD</b>	irrigation water	<b>-IW</b>	recreation	<b>-R</b>
* drinking water	<b>-DW</b>	land development	<b>-LD</b>	tourism	<b>-T</b>
* fishing	<b>-F</b>	land refill	<b>-LR</b>	waste water sink	<b>-WWS</b>

Value of Mansagar has changed over time with its changing spatial characteristics. From its existence till the mid twentieth century, Mansagar catered to values such as source of drinking water for humans and animals, irrigation, bathing and washing clothes, fishing etc. to the locals. The *Jal Mahal* palace was the royal family's leisure place for fishing, hunting and water sports. The main value was the year-round water storage for the palace-fort and the local inhabitants. The ecological value was high, though it was not explicitly a priority. The lake promenade served values linked to communal and religious activities owing to the presence of *Kanak Vrindavan*, *Ashwamegha Shala*, and *Parashuram Dwara* Temple. The hilly forests enclosing Mansagar from east to west in the northern side formed most of the catchment of the lake was used by the local inhabitants for hunting and forest extracts. The lake bed in the summer was used for farming.

Today, though the sewerage water flowing into the lake ensures water, the most value from the past is gone except the recreation value. Fishing, drinking, bathing, washing and sporting are also not active anymore. The two main values evident are the waste water sink and land for development as already discussed. Planning experts are concerned about the land conversion and waste water management plan for the city. At the same time they argue that recreation is a way to encourage people's association with the lake. They further argue that properly treated waste water is the only hope to ensure year round water in the lake and therefore maintain the lake ecosystem and also avoid land conversions.

Experts remark that although tourism was not directly associated with Mansagar in the past, the current restoration plan of JMTD is aimed at pushing tourism and recreation value. The restoration of Mansagar and the lake promenade development now attract many people of Jaipur to visit Mansagar. Boating is also likely to start soon. The top of Mansagar dam is converted into a public garden with local business group like the Rajasthan Patrika sponsoring the maintenance under their corporate social responsibility plan. The annual birding festival is a popular event that brings environmentalists and bird lovers to the Mansagar ([www.birdfair.org](http://www.birdfair.org)).

There is no commercial fishing but fishing theft is common. An official from Fisheries Department made a remark that to have or not to have fishes and fishing is a political and commercial decision made by few (referring to government officials and political leaders). For example, in the monsoon of 2009, the excess flow of untreated storm and sewerage water flow into the lakes resulted in the death of the entire fish stock



which became a big nuisance for the surrounding area of Mansagar. There is also an incidence of not allowing any water into the lake for dredging during the beginning or restoration activity which led to the death of fishes. Environmentalists urge for aquatic life in the lake since the birds and the replenishment of lake water quality are linked to the fish stock. Officials claim that fishing management strategy is underway.

## **6.7. Interactions (I) and Outcomes (O)**

### **O1- Collective Action performance, I1- Lake Maintenance activities**

Several organizations are collectively involved in the Mansagar restoration. Mansagar restoration was conceptualized in 2000 and the actual implementation started in 2004. The JMTD project actually caught attention of policy analysts/scholars because of the collective effort of several government and non-government organizations. There is also resistance to the collective action in terms of politicization linked to land, value, ecosystem, corruption etc. Experts from within the collective action group point out that although JMTDCL was formed to address the polycentric governance approach and lead a holistic approach to lake restoration; the project is facing typical collective action problems. Some officials remarked that it is difficult to sustain collective efforts if commitments are not fulfilled by the members. JMTDCL is an advisory body involved in assigning roles and responsibilities to the member organizations but has no statutory powers to ensure that member organizations are committed to the assigned tasks. Monitoring and evaluation is crucial. The task of monitoring and evaluation of the performance of the member organizations is unclear. RTDC officials in-charge of the JMTDCL is (holder of the escrow funds) see lack of enough criteria for the disbursement of the funds to the member organizations. There is growing tension among the JMRPL and JDA-JMC with regard to the disbursement of the funds to continue maintenance works. Coordination is crucial. There is a need for clear role of JMTDCL particularly in terms of coordination since it is appointed as the nodal organization.

The formation of the committee like ECID in JMTDCL brings officials of member organizations in deputation with additional responsibility. These officials have their own organizational activities which are priorities and therefore the tasks of JMTD remains secondary. Many officials in the new position have less power and motivation to pursue the assignments and newly recruited officials come with other priorities. This is also because the role and responsibilities within JMTDCL is unclear. JMTDCL has become yet another organization.

Who are included in the collective action is crucial. The JMTDCL does not include some important organizations such as State Pollution Control Board, Forest Department, Fisheries Department, Water Resources Department and Irrigation Department which reflects insinuation of tourism and commercial interest in setting up of the restoration plan of Mansagar. Mansagar restoration is driven by concepts like integrated river basin management (IRBM) and sustainable development (SD), in which people's participation is considered as crucial. Officials remark that concepts like IRBM and SD do not tell much about operationalizing people's participation in practice. Further, people's participation do not lead to solutions since restoration is a technical process. Instead people's participation brings delay in action. Finally, today people are least concerned about the commons and to some extent they are

responsible for the poor status of the lake because of ground water extraction, waste water and solid waste disposal and squatting. Officials remark that unless the people are conscious and concerned about their resources, any governance approach will remain a challenge. How to make people conscious? The answer goes back to designing new governance systems and building new organizations.

There are several interlinked activities involved in maintaining the lake (I), such as planning, financing, monitoring, evaluating, sanctioning, informing, technical support, administration, rule-making, feedback, dispute resolution, coordinating, consulting, whistle blowing, subtractable use, non-subtractable use, abuse, feedback and many more. They are phases, stages or simply steps of maintenance. They also attribute to the polycentric governance. A model of the collective action happening at various levels involving actors and governance systems in different phases of Mansagar restoration is represented in figure 11.

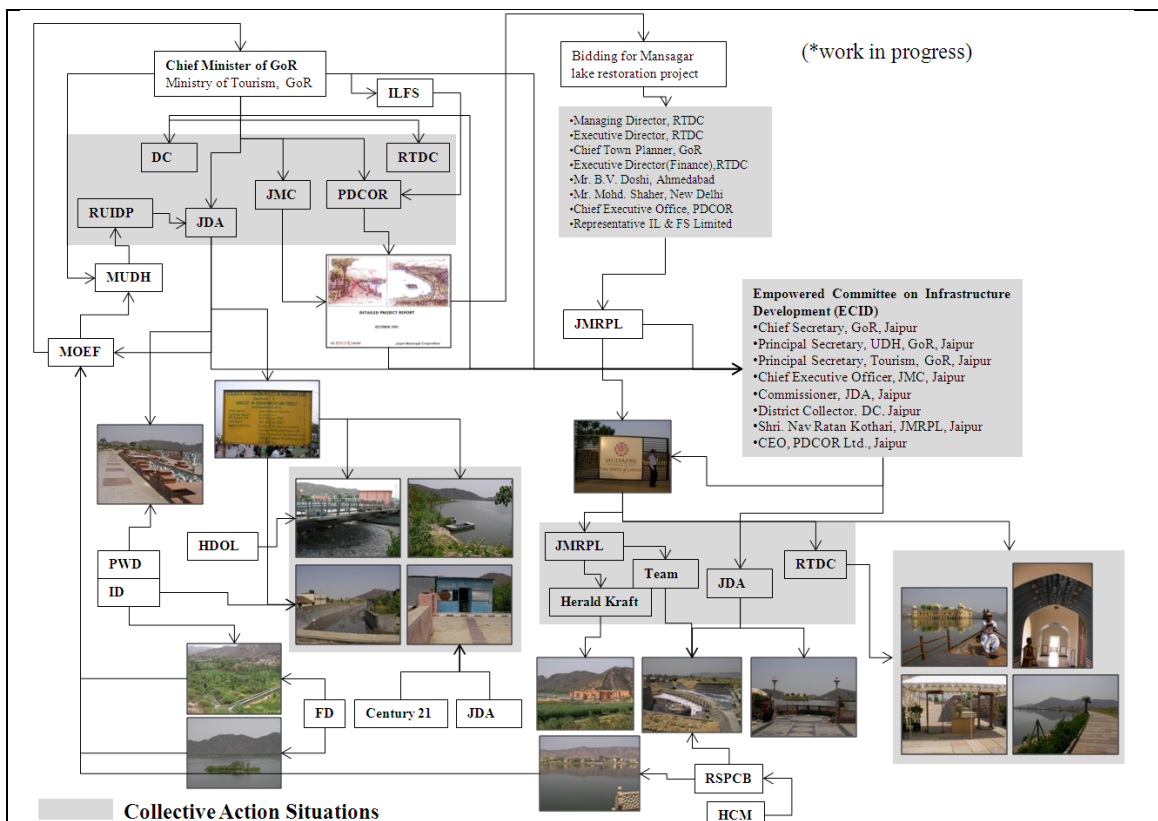


Figure 0-11. Simulation of collective actions towards ecological restoration of Mansagar Lake

It is important to make the collective action functional at the operational level in order to achieve the desired outcome of ecological improvement. This demands effective coordination mechanism between these interlinked activities as discussed above. One activity that binds all the activities is the information sharing. The asymmetric information and lack of information are typical collective action problems. Information that is available, stored, processed, and shared among the actors are crucial. The nature of information that is shared, the flow of information and the use of the information by the concerned organizations (to the level of officials) are important. It is found that translation of the different languages used for operational purposes are

kind of barriers. From Mansagar study following different style of writing and languages are identified at:

- various levels of actions: individual, operational, collective and constitutional.
- various sectors linked to the resource systems use: fisheries, agriculture, irrigation, recreation, infrastructure, bio-diversity, environment, use different scientific languages and data sets for research, planning and policy. There are problems in organizing information and documentation to share with others. On one hand there is a reluctance to share information and on the other hand there is a general acceptance that the information sent/received are of less use due to the incompetency of understanding.
- various organizations linked to the resource maintenance: planning, financing, monitoring, evaluating, sanctioning, informing, technical support, administration, rule-making, feedback, dispute resolution, coordinating, consulting, whistle blowing, subtractable use, non-subtractable use, abuse, feedback, GIS, policy, law, regulation and many more.
- various research disciplines, ex. ecology, economics, geography, history, political science, sociology and other disciplines (Bal, 2011).

Apart from the repetitive works, some observations on language are interesting. Even when similar scientific languages are applied by different organizations, different results are found, for example in statistics on water quality. This is attributed to: for whom the statistics are prepared. For example, SPCB (2010) report says that the BOD and COD in Mansagar have deteriorated, whereas the JMRPL (2010) report says it has improved since 2000. SPCB statistics are prepared for monitoring action whereas JMRPL statistics are for project appraisal. The scientific language used by one organization is usually not-understandable by others, for example the remote sensing data. Officials comment that apart from its scientific language problem, it does not tell anything at the operational level. Many reports are made to describe what is going on but fail to guide what should be done, for example some officials comment that they know Mansagar is polluted and they expect expert organizations to come up with solutions rather than status reports. This is widely echoed by officials involved on day to day lake maintenance. They add that eventually localized and instant solutions are the only way to address the everyday problems even though they are aware that some of the efforts are short termed and may lead to further problems. Officials cynically remarked that the scientific reports look good only in the shelves of bosses.

Lake maintenance is a slow and transitional process. Plans, proposals, agreements and assignments of responsibilities are time consuming actions. JMRPL, who are eager to develop tourism at the lake site, struggles with the cumbersome process of approvals particularly because the local officials change with the change in the political scenario at the city / state level and this, requires re-submissions resulting in delays. The pending legal cases against adds to the delay of approvals.

## **O2- Ecological performance of the lake, I2- Lake characteristic improvements**

The ecological performance of the lake is affected by the values that are stated and preferred vis-à-vis acted upon by the actors of collective action. The main challenges

of the ecological performance of Mansagar are the prevailing land, water and fund politics. The politics is attributed to the property rights, financial resources and the operational rules which affect the ecological performance of the lake.

Ecological improvement is a slow and transitional process in which every day operational issues are crucial. It is therefore important to record the efforts to assess signs of improvement over time. There are mixed opinions among the officials, experts and people of Jaipur regarding the ecological improvement of Mansagar but with a general agreement that there are signs of improvements in comparison to the condition of lake in 2000 particularly in the lake water quality; in the overall up-gradation of the area; and in designating the lake for its assigned purpose.

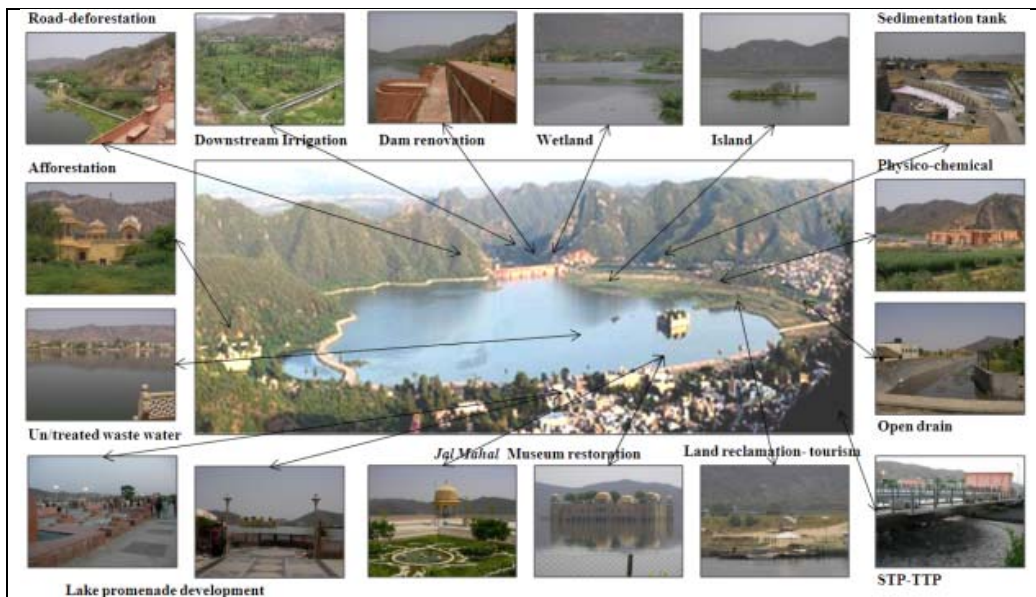


Figure 0-12. Photo evidence of the current ecological status of Mansagar environs

The nature of lake has changed over time particularly from storm water reservoir to sewerage water sink. The issue of waste water treatment is a concern but on the other hand, it is a relief since the waste water is the only continuous source of water for the lake. Jaipur, like most cities in India, is not in a position to afford to hold fresh water in Mansagar amidst the acute shortage of drinking water in the region. Officials and experts believe that addressing the waste water treatment is the optimal solution towards the ecological restoration of Mansagar. A photographic evidence of the current restoration activities is presented in figure 11.

## 7. DISCUSSION

Integrated studies of social and ecological systems reveal new and complex patterns and processes that were not evident when studied by social or ecological scientists separately. The approach helped to get deeper understanding of the operational-level issues of a lake system and learn to use the SES framework in analyzing urban lake systems. With respect to using the SES framework, it is found that analyzing multiple action situations happening at different levels forces shifting between the levels during the analysis. In many researches, this results in analysing at one level and making inferences/recommendations for the other levels. Similar, challenge

exists in measuring two action situations at two different arenas such as social factors and ecological factors for example, Sharma et.al. (2008) studied the physico-chemical characteristics of Mansagar lake water from 2005-07 and came up with the conclusion on quantity of land that should be used for sedimentation and be reclaimed for development.

The assumption that specific governance system (here collective action), at its core, is driven by the value/s generated or the value/s expected from lake system can be argued that collective action within a polycentric governance generate certain values of a lake system. It is realized that both propositions are true and the causation is dependent on temporal and spatial characteristics of the social-ecological systems. In addition, it is dependent on the social or ecological events or disturbances that occur within the social-ecological systems life time. Conceiving of social-ecological systems and the events and disturbances that affect them as distinct objects is thus important (Schoon and Cox, 2010). It is realized that the outcomes are co-produced by the interactions between them for example, the vision of a leader and the death of the fishes triggered the restoration of Mansagar.

Governing social systems to govern ecological systems is a cyclic process, in which the present system aspires to improve the past and present problems and in the process of doing so it creates new set of problems for the future. It is thus difficult to prove the general assumption that collective action directly results in lake improvements although the observed pattern of collective action shows a link between the happenings of one (improved lake) due to the other (collective action). The findings will hopefully allow policy makers, practitioners and researchers to pursue more refined strategies of governance systems, where an incremental and modest changes in allocation of responsibility, authority, commitment, accountability, resources, financial responsibility, evaluation and monitoring, public information, etc.

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