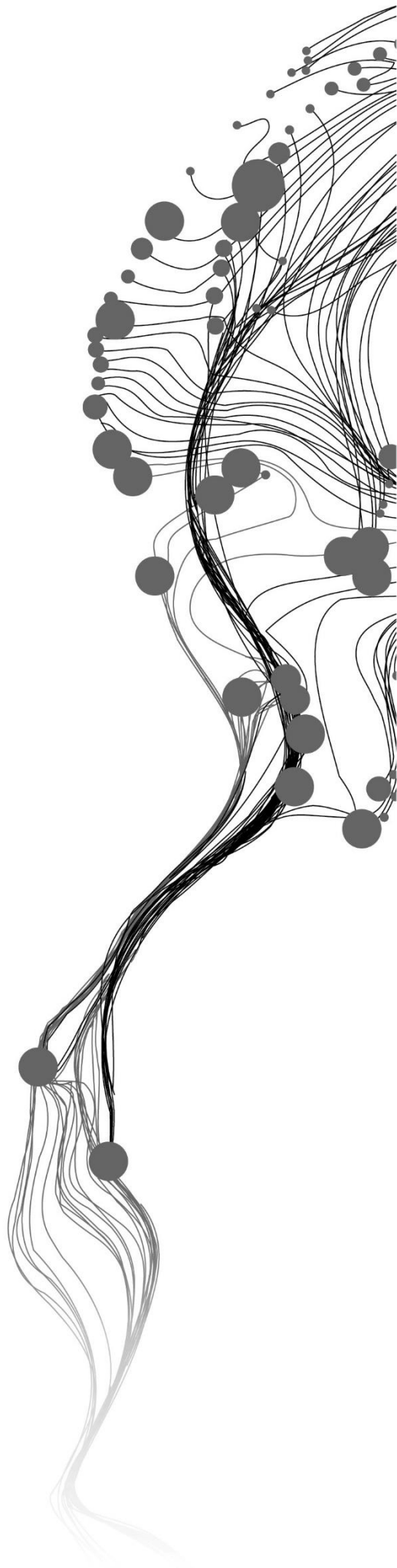# RETHINKING ECOSYSTEM SERVICES IN THE URBAN FRINGE, OPPORTUNITIES IN HUMAN WELL-BEING - THE CASE OF PANJU ISLAND, MUMBAI

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ABSTRACT

The well-being of us, human beings are dependent on the natural environment in multiple ways. The benefits we receive from the natural environment, the ecosystem services play a major role in sustaining the wellbeing. The dependency ranges from food and fibre as provisioning ecosystem services to enjoying a beautiful landscape as a cultural ecosystem service. However, does everyone receive these benefits in the same way? Does an assessment of cumulative availability of ecosystem services translate to wellbeing outcomes? No, there are multiple factors which mediate this outcome; they are the capabilities. Current mainstream ecosystem service research does not consider these mediating factors into account, and they are focussed on aggregated perspectives. This is because such explicit characterizations are complex at large scales studies. This study investigates such aspects at a micro-level through a bottom-up approach. It explores the availability, use, and changes related to ecosystem services at an individual level and highlights the importance of such ecosystem service information in local-level decision-making process and management.

To understand, assess and develop a methodology to perform such micro-level studies which can support local-level decision making a small case study was conducted. A small estuarine island in the outskirts of Mumbai was chosen because of its pristine ecosystem and geographical characteristics. The stand-alone nature of the island and its people made the choice of spatial scale easy. In addition to that, it gave freedom to look it to multiple aspects due to less complexity.

The micro-level investigation proved there are many opportunities available related to ecosystem services which will ultimately support the well-being of the residents of the island and will lead to a self-sustained future of the island.

Keywords : Well-being, Ecosystem services, Capability, Non-monetary evaluation, Ecosystem service valuation.

ACKNOWLEDGEMENTS

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1. INTRODUCTION

It is well established that ecosystem services (ES), understood as the benefits that humans receive from nature, and are indispensable for the survival and well-being of human beings on earth. The interlinks between human well-being and ES define the benefits human beings receive from nature and its contributions to well-being (Burkhard, Petrosillo, & Costanza, 2010; Costanza, 2000). At the fundamental level, the survival of human beings on earth is entirely dependent on the benefits which societies receive from nature. Costanza argue that the benefits provided by ecosystems are unaccounted and are of greater magnitude compared to the standard economic metrics (Costanza, 2000). Similarly, assessments of interventions to conserve ecosystems show that the benefits are of greater magnitude compared to the actual costs of interventions (Balmford et al., 2002). Assessment of ES in economic metric not only conveys the controversial message of substituting ES with money, but it also supports the idea of short term non-sustainable solutions. Although such assessments at large scale supports the policymaking process, but it is not inclusive as it misses out many information.

Despite the well-known importance of ecosystems, many rudiments of human-environment relationships are not explored well. Especially in a megadiverse (with diverse cultures and ecosystems) country like India, assigning generalised importance and value to ecosystems are often problematic and challenging due to differences in perception among stakeholders (Cordero, Suma, Krishnan, Bauch, & Anand, 2018). To tackle this and assign values to ES, a perception-based assessment of ES is required (Deka, Tripathi, & Paul, 2019). Human action and behaviour towards ES are based on how an individual perceives different benefits received. Perceptions of ES, changes, and drivers of change needs to be studied to understand the human-environment relationship better and to prioritise conservation or development activities. This study is an approach towards exploring such perceptions by employing social research methods, namely semi-structured interviews.

A better understanding of the contributions of ES to human well-being can inform policymaking adequately. Well-being is a multidimensional concept; the presence and availability of multiple factors mediate human well-being. For example, this study investigates well-being in terms of, basic materials of for good life, freedom of choice and action, human health, social relations, and safety. How different ES contributes to these dimensions is possible only through studies on the synergies between humans and nature. However, most of the studies available are backed up by only scientific information (biophysical assessments) or monetary evaluation (payment to ES); for example, carbon sequestration, forage production (Nagendra, Sudhira, Katti, & Schewenius, 2013). It gives more emphasis on the quantitative analysis, and not much emphasis has been carried on how people perceive existing ES benefit and its potential. In addition to that, the studies did not provide proper attention to the vulnerable population living in the urban fringes or poor conditions. Such people are living in socially and physically sensitive conditions. In addition to that, existing ideas and concepts on ES and links to well-being are based on an aggregated perspective.

Resembling the research gap in ES related studies and existing policies (Annex 8.1) related to environment and wildlife also shows a gap. The selected indicators of existing policy instruments of informatory nature like NABP of 2014 (National Biodiversity Action Plan) has a very quantitative character (Badola, Hussain, Dobriyal, & Barthwal, 2015). Assessments are being done in large scales and are being imposed at the local

level, thereby bringing in conflicts between the local people and the authorities. The large scale assessments convey an overestimated benefit of cumulative availability of ES will lead to linear well-being outcomes for everyone (Szaboova & As, 2016), but it is not true, how different communities and individuals receive this benefit is based on how accessible it is to them.

This research is an approach towards understanding the human environment relationships in non-aggregated perspectives and in addition to that, highlighting the need for instruments which supports an informative and inclusive local decision making. Furthermore, how it can lead to a participatory and sectorally coordinated approach to sustain local well-being and ecosystem services. With a focus on human well-being, the processes, and the functioning of ES. A small geographical area was chosen to conduct the study, the study area is an estuarine island (it reduced the complexity of interconnected ecosystem services and the problem of defining ecosystem boundary) in the peri-urban region Mumbai. As the island has diverse ecosystems and people, the results and conclusions can be generalized.

1.1. Study area

Panju is a small estuarine island in the north of Mumbai Metropolitan Region (MMR), ecologically and historically it is a unique place. MMR comprises many estuaries and creeks. There are three islands, namely Panju, Wadhiv, and Jhow, situated in the estuaries. They are similar in several aspects and have peculiar characteristics. Being close to the city of Mumbai, they are ecologically relevant. Even though these islands are in MMR, they suffer due to poor transport and inaccessibility. These islands are in rural-urban fringe, facing an immense pressure of urban expansion, and may become part of Mumbai city shortly (Ajay Kamble, 2015; De Sherbinin, Schiller, & Pulsipher, 2007; Gandy, 2008; Gupta, 2007).

Figure 1 Entrance of the village Source: Google images

Panju island lies in the Vasai creek (Figure 1) In the north of greater Mumbai region in India. It has a maximum elevation of one meter from the mean sea level. The island consists of around 1500 residents in a 600-acre land with approximately 400 houses. The island margins have mangroves and interior have been cleared for cultivation and saltpans. The ferry (Figure 2) is the only mode of safe[1] transport available to go to the village

(the other mode is walking through the abandoned railway bridge, which is considered as dangerous (Figure 3).

Residents of Panju have initially been farmers and fisherman's, and some are into the sand excavation and salt production (salt pan) (Dabre, 2019).

Figure 2 Everyday boat ride to the village. Source: self

People from outside consider Panju as an island with no potential and exposed to multiple hazards (study area map Figure 4). However, Panju and its people have an enormous potential to become a self-sustained village. Due to the availability of different ecosystem services and better living conditions with respect to neighbouring villages (for example, Vasai fishing village). It is true that Panju and its people exist separately from the mainstream and faces several issues due to marginalisation. Still, with proper attention and informed decisions, it can utilise its potential to rise (based on own observations and based on information collected during the data collection process).

Figure 3 Alternative access option to the island, abandoned railway bridge. The bridge is owned by the southern railway and has already issued notices related to demolishing the bridge. Source: google images (The man in the image is for reference)

Panju island is one among the 53 panchayaths[2] in Vasai Mahanagar Palika (Municipal corporation). Vasai also includes four more municipal corporations. The island has a rich history of contributions to the nationalist movement and historical importance from the period of Maratha regime. Like mentioned above, the island is still disconnected (in terms of accessibility, political exclusion) from the mainstream even today. The historical shreds of evidence are available from the Portuguese rule India (1600's). While the British had control over the seven islands of Mumbai (Mumbai was an archipelago, before the British

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[1] A person can also choose to walk through the abandoned railway bridge, but it is not a safe option. Due to the remoteness of the location, that area is infamous for theft and illegal activities. This information is collected from the stakeholders during the visit.

[2] Village council

connected these by land reclamation from the sea) (Riding, 2018); the Portuguese had control over the northern part of Mumbai (Vasai, Naigaon). There are notions of the island from that period.
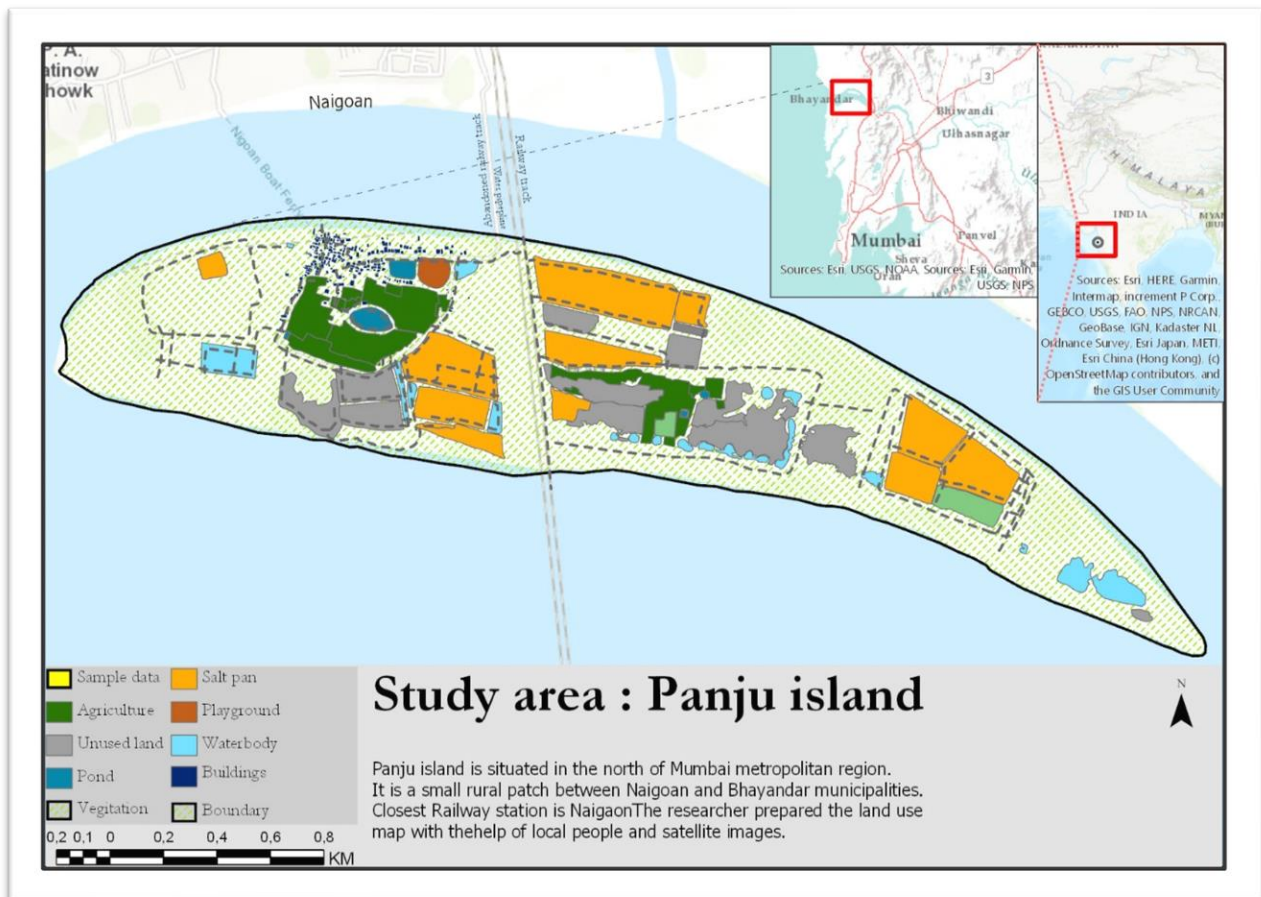
Figure 4 Study area map. The map is created from the inputs received from the residents of the island and the satellite imagery.

1.2. Background and justification

Problems of environmental change and pressure on ecosystems due to urban expansion have become more apparent, and this increasingly makes human beings realise how much we are dependent on ES. At the same time, it is less clear how different individuals perceive this benefit. Studies aimed at assessing ES benefits in the past gave more focus to marketed (e.g., production in tons, fish catch per year) values than non-marketed (provision of clean water, cultural values) values (Douglas, 2018; Gómez-Baggethun & Barton, 2013; Gowdy, 1997). This means only a portion of ES made their way into this assessment. A holistic approach, including marketed and non-marketed values, is required to understand relationships between human well-being and ES. This study is aiming at exploring interlinks between ES and human well-being in a peri-urban community. Even though the ES concept attracted considerable attention in the past decade, it is mostly limited to monetary or biophysical evaluation. There is only a narrow range of literature available on socio-cultural evaluations, compared to monetary or biophysical assessments. Among the research available, there is a thematic divide in the availability of research done on the global

south. Compared to the emphasis given to the cultural ES and its effects on health and well-being in the studies conducted in the global north (Szaboova & As, 2016), studies in the global south focus on direct dependencies between people and ecosystem services, thereby focus is on looking at ES as a possible service for poverty alleviation (Szaboova & As, 2016).

This study has its primary focus on provisioning ES. The case study area is a peri-urban estuarine island in the north of Mumbai. From the preliminary visit to the study area and newspaper reports (Dabre, 2019), it is clear that people living in the study area are moving from a self-sustained (in terms of livelihood opportunities available inside the study area) to a more dependent one. Now, people started commuting from the island to the central city for jobs, this changed the management practices, and it reduced the supply from the provisioning ES (agriculture, saltpan). In addition to that, the island was recently declared as a place with tourist potential (Bose, 2016), and the local government is planning development activities within the village. This can impact the already existing ES (managed and as well as unmanaged).

As mentioned in the preceding section (Study area) ecosystems of the study area is vital for the city (Mumbai) in many ways (climate regulation, recreation, other provisions). Absence of activities and lack of industries on such isolated island does not encourage population influx (as long as no new transportation facilities are made). At the same time, the same reason does attract new development plans inside the island. Its ecosystems thrive, mainly because there is no harmful interference on environment till now. An exploratory study on interlinks between human well-being and ES can lead to informed decision making, thereby reducing the environmental impact due to impending urbanization (Ajay Kamble, 2015).

This study explores how different ES are related to human well-being. It analyses the benefits received, the changes over time and the drivers of change according to stakeholders[3] (residents of the island). This can produce an overall idea of ES and potential of the study area (in terms of using ES service to increase the well-being of the stakeholders). Combining with the future development plan, this can lead to inclusive and informed policymaking. The proposed study collects information on the knowledge and perceptions of the community about the environment, to govern the sustainable use and management of resources. So, it is crucial to know how the stakeholders perceive ES benefits and how do they associate it to their well-being. In addition to the stakeholders' perceptions about the ES benefits, it is also essential to look at the expert's perspective literature (place-specific scientific literature, government documents) for more practical evidence-based information on ecosystem services and it is interlinked between human well-being.

1.3.   Research Aim

Aim of this research is to explore the interlinks between ecosystem services, its use, management, and consequences in for stakeholder's state of well-being on a micro-level. In addition to that, highlight the importance of such information in local-level decision making and management.

1.4.   Objectives and research questions

1) **To understand the essential aspects of well-being as perceived by stakeholders**
   a. What are the objective (material) conditions of well-being essential for the well-being of stakeholders?

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[3] Throughout the text, stakeholders mean residents of the island.

   b. What are the subjective (non-material) conditions of well-being essential for the well-being of stakeholders?

2) **To understand stakeholder's perception about the benefits received from provisioning, cultural and regulating ecosystem services and the changes occurred.**
   a. What benefits do stakeholders receive from ecosystems?
   b. According to stakeholders, where is the provisioning, cultural and regulating ecosystem services located?
   c. Do stakeholders perceive that the benefits received from ES changed? If so, what changed?
   d. If the stakeholders perceive the benefits received from the ecosystem changed, what are the drivers of change according to stakeholders?
   e. Do the ES benefits vary in different seasons? If so, what is the variation in benefits received according to stakeholders?
   f. Are there differences in perception among stakeholders about the benefits received? If so, what are the factors influencing this change?

3) **To explore the interlinks between ecosystem services and human well-being.**
   a. Which ecosystem services are crucial for the well-being of the stakeholders?
   b. What are the differences when comparing, the views of the experts on available ecosystem services with the perception of stakeholders?

4) **To reflect and conclude how ecosystem service information can be operationalized to enhance well-being at the local level.**
   a. How to integrate ecosystem service information in the policymaking process to enhance human well-being?

1.5.   Concepts and frameworks

The conceptual framework (CF) (Figure 5) explains why different concepts are studied to understand the interlinks between ecosystem services and human well-being (the focus of the study). Each box represents a concept and its components. Black titles in boxes (also in sub-boxes) represent the main elements. Blackline connecting boxes represents flow and connections, black lines represent the scope and focus of the study, and dotted lines represent the relevant concept but not included as a major concept. This conceptual framework provides a platform to facilitate an understanding of human-environment relationships. This study investigates stakeholder's perception of each concept mentioned in CF and what influences their perceptions. The conceptual framework describes human wellbeing in two major dimensions and subdimensions; major dimensions are objective and subjective wellbeing conditions. Other concepts, directly and indirectly, influence human wellbeing. For example, anthropogenic asset influences human wellbeing directly as well as a catalyst to natural or anthropogenic drivers.

The conceptual diagram includes six major concepts, nature, nature's benefits to stakeholders', drivers of change, human wellbeing, institutions and governance and anthropogenic assets. The diagram explains how each of them is related and, when combined, affects human well-being.

1.5.1. Nature

IPBES framework (Díaz et al., 2015) explains nature in terms of biodiversity, ecosystem structure, functioning, but those things are out of the scope of this proposal. Here in this CF, the concept of nature explains the presence of natural resources benefits stakeholders' and contributes to well-being. Examples include the presence of timber, presence of freshwater source, and presence of a species. The scope is only limited to benefits which human beings are mediated. Other benefits which are not mediated by humans are out of the scope.
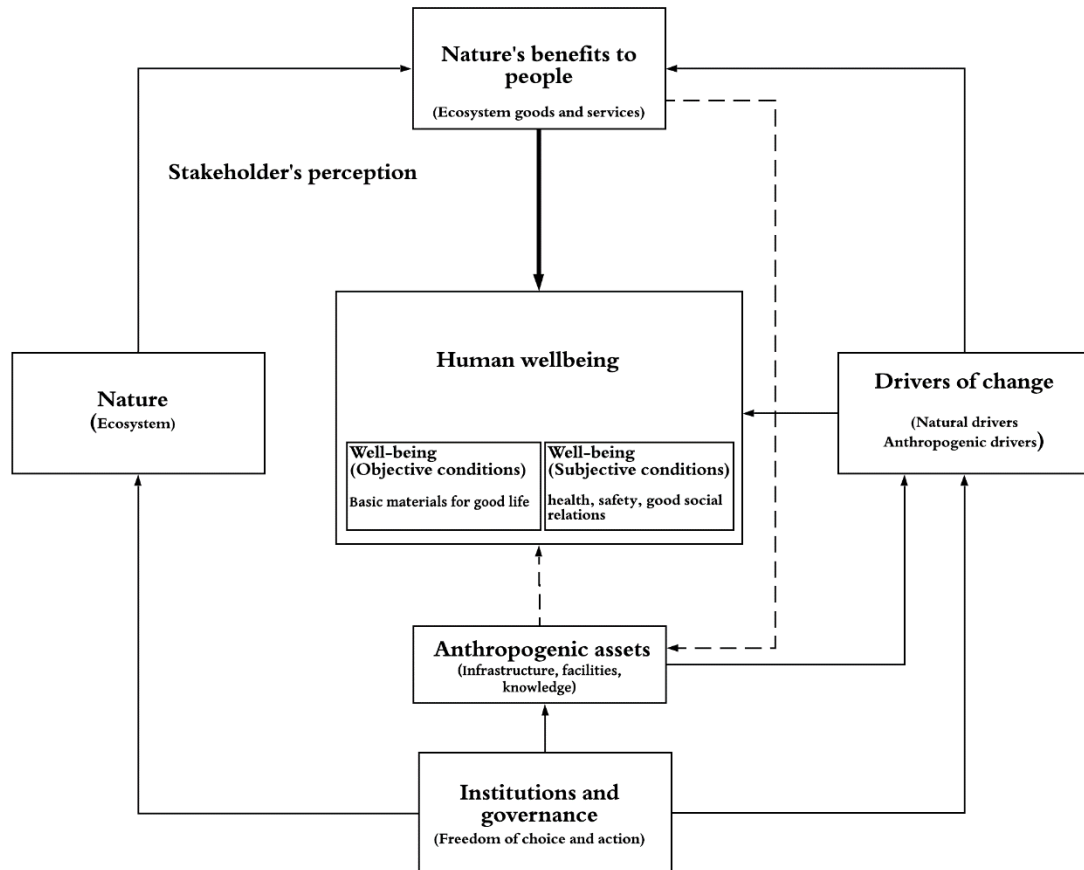
Figure 5 conceptual framework (improvised version from (Díaz et al., 2015))

1.5.2. Nature's benefits to people

It refers to the benefits that humans obtain from nature. In general, the kind of benefits which they receive is categorised into three classes, provisioning ES, cultural ES, and regulating ES, and these services can be called as ecosystem goods and services. The benefits need to be understood within the context of bundles of multiple benefits to stakeholders', and what are the values assigned to it by the stakeholders (Díaz et al., 2015).

1.5.3. Drivers of change

As mentioned in the introduction section, changes occurred to ES is a crucial aspect to look at. It explains what has affected the ecosystems and how benefits received changed over time. Anthropogenic (human

made) and natural (natural, change in weather, etc) are the two drivers of change; they both act as direct and indirect drivers based on the context. Anthropogenic drivers are the results of human decisions and actions. Examples are changing management practices, abandonment, and land conversion. Natural drivers of change are beyond human control, for example, extreme weather events, seasons, drought (Díaz et al., 2015).

1.5.4. Human well-being

The CF explains human well-being with its two components, objective, and subjective conditions of life and how ES influences them. *Objective conditions of well-being* explain material demands for a better life, and it explores the material benefits like income (livelihood support), water, food and capabilities which helps stakeholders to access and enjoy these benefits (education & skill level). *Subjective conditions of well-being* it is multidimensional and context dependent. It explores perceptions about different conditions like health, safety, good social relations, and freedom. (or their perceived relationship with nature) (Duraiappah et al., 2005; Haines-Young & Potschin, 2012; Walter V. Reid, Harold A. Mooney, Angela Cropper, Doris Capistrano, Stephen R. Carpenter, Partha Dasgupta, , 2007).

1.5.4.1. Objective conditions of wellbeing

Objective conditions of wellbeing have only one subdimension, the basic materials for good life. It includes four indicators livelihood, income, skill, education, Access to water, Access to food[4] (Díaz et al., 2015; Walter V. Reid, Harold A. Mooney, Angela Cropper, Doris Capistrano, Stephen R. Carpenter et al., 2007). This dimension explores the basic necessities the stakeholder requires for wellbeing.

1.5.4.2. Subjective conditions of wellbeing

Perceived safety: changes in provisioning services affect supplies provisioning ES, and it increases the likelihood of ES induced perception of safety, like the presence of mangroves and its flood-prevention capacity increases the perception of safety, or an uninterrupted provision of ES supports the livelihood. Presence or absence of regulating ES influences the frequency of occurrences of damages due to weather events. Changes in cultural services like spiritual attributes of ecosystems lead to a weakening of social relations in a community (Díaz et al., 2015; Walter V. Reid, Harold A. Mooney, Angela Cropper, Doris Capistrano, Stephen R. Carpenter et al., 2007).

Perceived health: provisioning ES and regulating ES, influences the perceived health of stakeholders. For example, the availability of food, freshwater and other resources contributes to health, thereby increasing the feeling of being healthy (Díaz et al., 2015; Walter V. Reid, Harold A. Mooney, Angela Cropper, Doris Capistrano, Stephen R. Carpenter et al., 2007).

Perceived social relations: The changes and presence in different ES affect the overall social relationships in the study area (Díaz et al., 2015; Walter V. Reid, Harold A. Mooney, Angela Cropper, Doris Capistrano, Stephen R. Carpenter et al., 2007). For example, an ES related livelihood activity in the study area increases cooperation and social cohesion.

1.5.4.3. Institutions and governance

Institutions and governance systems define how stakeholders' and societies organize themselves and their interactions with nature (Díaz et al., 2015). Freedom of choice and action is mostly related to institutions and governance mechanisms. It is a capability which allows stakeholders to enjoy different services. It defines whether the stakeholders possess enough freedom to act and make changes on their own on ES or are there any other constraints. This has an impact on drivers of change as well as the ecosystems itself (Díaz et al., 2015; Walter V. Reid, Harold A. Mooney, Angela Cropper, Doris Capistrano, Stephen R. Carpenter et al., 2007).

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[4] Refers to local production and accessibility

1.5.5. Anthropogenic assets

It is the human-made facilities and other assets. It is important to include anthropogenic assets in the CF because the perception of stakeholders on ES benefits vary based on the presence and absence of anthropogenic assets. For example, value given to a freshwater source by the stakeholders is less when there is a water filtering plant or piped water connection (Díaz et al., 2015). As described in the CF, the proposed research investigates such factors to explore opportunities.

1.6. Thesis structure

The research contains six chapters. Chapter one sets the background and justification, followed by the research objectives and questions and conceptual framework. Chapter two examines the relevant literature that describes the theoretical discourse on major concepts. It also provides insights on interlinks between ES and human well-being, and the research gaps in the ES and well-being studies. It concludes with an overview of dimensions to approach the main aim of the study, both theoretically and empirically. Chapter three includes the research design and methodology of the thesis. Chapter four presents the results, and Chapter five presents a discussion on findings and policy recommendations. Chapter six concludes the major research conclusions, recommendations and limitations.

2. LITERATURE REVIEW

Several literature searches were done to understand the different conceptualizations of ecosystem services and human well-being. The literature search was conducted with mostly Web of Science, Scopus and a few received from connections in ResearchGate. Apart from a general literature search on a global scale, another restricted location search was conducted to understand previous studies conducted in Mumbai. This section describes a summary of all research papers reviewed.

2.1. Ecosystem services: frameworks, classifications, and related work

Ecosystem service research has progressed at different levels from conceptualisation's, assessment frameworks and applications. The term ES made prominent by the Millennium Ecosystem Assessment (MEA) (Douglas, 2018), but was coined in the 1980s as part of the sustainable development debate. The MEA drew findings across development economics, resilience theory, and systems modelling to advance the concept of ES and its applications, but it was more focused on delineating and classifying ES types, processes, mapping and evaluating the benefits. MEA is a structured approach towards communicating the importance of ES to stakeholders' as well as to the policymakers. After decades of hushed development, MEA was a milestone and kept ES in policy agenda (Correa Ayram, Mendoza, Etter, & Salicrup, 2016; Duraiappah et al., 2005; Pulver et al., 2018). This paved the way to many different classifications and frameworks to assess ES benefits.

Based on local context and need, different classification schemes and frameworks were evolved. Classification of ecosystem service and ES assessment framework is based on what constitutes an ES, its characteristics, and the decision-making context. Ecosystems which provide direct provisioning for humans through food, fibre, timber, and other resources are known as *provisioning ES* (Walter V. Reid, Harold A. Mooney, Angela Cropper, Doris Capistrano, Stephen R. Carpenter et al., 2007). Ecosystems which supports regulation of nature through absorption and processing pollutants or protecting human

habitat from external events (heat, wind, flood, or other events) are known as *regulating ES*. The Benefits which stakeholders' obtain through recreation, tourism, spiritual enrichment, aesthetic experiences are known as *cultural ecosystem services* (Butler & Oluoch-Kosura, 2006; Butler & Willis, 2006). ES mentioned throughout this proposal is the aggregate of the benefits (e.g. food, water) received from nature rather than the intermediate processes (e.g., agriculture).

Similarly, following MEA, many studies and assessment frameworks came up around the world. Notable frameworks are TEEB (The Economics of Ecosystems and biodiversity), CICES (The Common International Classification of Ecosystem Service) IPBES (The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services). The frameworks mentioned were built for different purposes and scale, MEA (global-scale) is more focussed on human well-being, TEEB (global-scale) is more focused on economic valuation of ES, CICES (scale-Europe) based on ecosystem accounting, and IPBES (global-scale) is focussed on biodiversity. It incorporates indigenous/local knowledge and stakeholder engagement (Pulver et al., 2018). In summary, all the ES assessment frameworks are based on MEA and talk about the same (less or more detailed) classes of ES. The choice of which ES framework to consider for a specific case is tricky, and in most cases, ES frameworks need to be adapted to match the needs of a specific case. Key selection criteria are end-use, purpose, flexibility, and extent of the classification system. This study uses MEA (improved) based on the selection criteria.

2.1.1. Multifunctionality and ecosystem services.

The direct and indirect benefits we receive from nature based on its functions are classified into two, multifunctionality and ecosystem services. A major change in the way the world looks at agriculture changed around the 1970s due to an increase in concerns on productivity-driven agriculture and its effects on environmental quality. A shift occurred at that time towards more sustainable practices and strategies (Huang et al., 2015). Fundamentally, the benefits from ecosystems can be differentiated into two, based on its functions and provisioning mechanisms, multifunctionality and ES (Rusche, Reimer, & Stichmann, 2019). Multifunctionality refers to farming activities, for example, production processes, inputs, outputs, and its contributions to different social, economic, and environmental dimensions. ES refers to its biophysical structure, processes, functions, outputs of agroecosystem influenced by farmers interventions, and four categories of ES, provisioning, regulating, cultural and supporting.

Both multifunctionality and ES recognize different benefits from agriculture. However, the problem is that mainstream research looks at these separately, one, based on inputs and outputs where the focus is only on the production model, two, looks at ecosystem services alone. Huang suggest that there is an excellent value in integrating these two approaches (multifunctionality and ecosystem services) (Huang et al., 2015). This study combines these two approaches, So ES in the study refers to a combined value.

2.2. Human well-being

Ethica Nicomachea by Aristotle is probably the initial works on well-being, which looks at the nature of human actions as it is aimed at happiness (modern literature defines the same as well-being) (Finneran, 1947; Marenbon, 2004). However, over time, measurements got monetized. The ethics part of economics got lost in the way, and development and growth started being defined in terms of GDP (Polack, 1988). Nevertheless, a recent increase in the number of journals and publications on quality of life, well-being, happiness, gives a hint that concepts like the quality of life, well-being and happiness are getting more and more relevant in economic considerations. A large amount of research is being carried out these days

which consider the well-being of human beings as an integral part of the development of a country (Adler & Seligman, 2016; D'Acci, 2011; Witten, Exeter, & Field, 2003).

Previous research gives evidence that wealth and well-being do not possess a linear relationship. For example, the well-being of citizens of a country does not improve based on the wealth of a country (D'Acci, 2011). This proves that well-being is not just about the richness and cannot be measured with GDP or any other monetary evaluation. Well-being intrinsically is a multidimensional concept (Akinsete, Apostolaki, Chatzistamoulou, Koundouri, & Tsani, 2019; Sitas, Prozesky, Esler, & Reyers, 2014) which is influenced by various intangible factors like the natural environment, aspirations, social relations, and health. This makes measurement or assessment of well-being complicated; it cannot be measured cardinally. At the same time, this can be measured ordinally by investigating the relative preference of two different utilities (axiom: utility means preference), for example, comparing the stated preference among two items. (D'Acci, 2011). So, well-being is a hedonic experience where well-being is a product of an individual's experienced utility (or preference). This leads to another question, rationality, how much of a person's decisions lead to increased "experienced utility"? Not all decisions are rational and contribute to well-being. Seligman define well-being as "Well-being theory deny the topic of positive psychology is a real thing; rather the topic is a construct – well-being – which in turn has several measurable elements, each a real thing, each contributing to well-being , but none defining well-being." (Dodge, Daly, Huyton, & Sanders, 2012, p.226). This makes measuring well-being as objective and subjective essential; well-being constitutes a set of building blocks aimed to flourish life (Dodge et al., 2012).

To conclude, the multi-faceted concept of human well-being represents a state of intrinsic value of an individual or collective, incorporating fundamental constituents of human existence (Akinsete et al., 2019; Anand, 2016). Well-being is a multidimensional concept, integrating objective condition of stakeholders' (objective conditions of well-being), their subjective assessment of life (subjective conditions of well-being) and also their relational aspects (social relations and participation in society, freedom of choice and action) (Adler & Seligman, 2016; Díaz et al., 2015). In contrast, fundamental constituents of well-being as per MEA are health, freedom of choice, good social relations, basic materials for a good life, and security (Walter V. Reid, Harold A. Mooney, Angela Cropper, Doris Capistrano, Stephen R. Carpenter et al., 2007). These components refer to what a person values doing or being (Anand, Hunter, & Smith, 2005). Also, the components of well-being are represented and perceived differently across cultures. So, it is essential to explore local criteria of well-being.

2.2.1. Measuring well-being

There is an increase in demand for a rigorous methodology to measure well-being, which goes beyond the economic metrics. Due to the lack of a radical explanation for the definition of well-being, measuring it always been a challenge (Alkire, 2008). Ongoing international experiments on happiness and well-being indexes around the globe like, in the UK, The Netherlands, Germany, Australia, and Canada gives hope on institutionalized measurements of well-being which goes beyond GDP (economic and utilitarian metrics). The current widely used measurements of well-being based on availability and access to resources in monetary terms do not always convey the actual message or have information about the well-being of people. Reason being, the standard well-being measures reflect only the resources in command by different individuals, like income or consumption. What makes non-monetary assessments different and interesting is, it gives insights on the access to different resources, for example, access to housing, and other necessities. Amartya Sen proposes the capability approach in this context (Sugden & Sen, 1986). It highlights the importance of looking into capabilities to measure well-being.

2.2.2. Sens's capability approach: Theory and practice

Sen's conceptualizations on the multidimensional nature of well-being and poverty are widely recognized as a novel approach (Alen Bryman, 2012; Robeyns, 2006). This thought pertains to a long line of reflections from philosophers, including Aristotle and Karl Marx. The core idea of the capability approach is that the measurement of well-being should be based on people's capabilities, rather than utilities and resources. The fundamental characteristic is that it views the resources and the core of all income-based approaches only as an instrument to achieve well-being. In general, Sen's view has a clear difference between means and ends[5]. The approach strongly supports the ability of an individual to have goals and pursue them.

Capability is a combination of various functioning. Functioning are beings and doings that people value and have a reason to value (Gasper, 2007; Sen, 1985). It includes some elements like being literate, being safe and well-nourished. It can also be some complex achievements. Capabilities are the freedom available to achieve this functioning. In Stiglitz–Sen–Fitoussi report functioning is defined as a set of broad activities and situations that people spontaneously recognize to be important (Noll, 2011). It is also comprehended as a collection of observable achievement of individuals[6]. According to Amartya Sen, well-being is a summary of peoples functioning. Sen's capability approach also suggests these functioning must be looked in a plural sense; one cannot replace the other one (Sugden & Sen, 1986).

Coming back to the capability, Sen's approach defines capability as an opportunity and freedom[7] to achieve "functioning". The Sen-Stiglitz Fitoussi report describes the concept of freedom as an essential element in the capability approach which illuminates the full range of opportunities available and open to them (Noll, 2011). It emphasises the idea of focussing on individuals, in a way that they can contribute to their own development (Noll, 2011). The capability approach itself does not select the dimensions of well-being. However, the capability approach is just a set of guidelines to choose them and link them accordingly. Its application is different depending on the purpose, geography, place, the level of analysis, availability of data resources, and the policies[8].

The dimensions of well-being explained are adapted from the proposed dimensions in Stiglitz–Sen–Fitoussi report. The report suggests eight dimensions, material well-being[9], health[10], education, personal activities[11], political voice[12], social connections[13], environment[14], and insecurity[15]. These dimensions together act as a mirror image of well-being (Alkire, 2015). The idea of combining these elements is criticized by many authors; interpretations of Sen's approach by many authors suggest that it is not a good

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[5] Resource-based measurements investigates what is available for an individual, but not what capability does the individual have to utilize them. In general, the availability of resources does not directly translate into well-being. This is because a set of individual conversion factors are involved which enables him or her to utilize it.
[6] Health, having a meaningful job, place to stay etc.
[7] According to Sen's capability approach, freedom has two aspects. One is the process aspect where freedom is defined as the ability get what mattes to an individual (Robeyns, 2006) for example institutions movements and democratic practices. Two the opportunity aspect, it explains the real opportunities available.
[8] The policy which the study is going to support.
[9] Income, consumption, and wealth
[10] Perceived health
[11] Work, ability to work
[12] Governance, ability to participate in decision making process.
[13] Connections with the society, social cohesion
[14] Present conditions and expectations about the future
[15] This includes both economic insecurity and perception about insecurity related to the physical nature.

idea to combine different capabilities and functions[16]. In the first place, it affects its plural nature (Loomes & Sugden, 1982; Sugden & Sen, 1986). In that case, the most compelling suggestion comes from Fleurbaey and Blancher, their writings rejects the idea of assigning weights (Serafy, 2014). It is important to note such approach gives room to assess things, people, value, and reason to value; this enlarges the consensus and allows the assessment to focus on capabilities rather than "functioning". Besides, it allows people to choose their own functioning. This study uses a plural approach, it recognizes different capabilities (skill level, education, livelihood activities, income), and functioning (freedom of choice and action, health, safety) as separate entities, and combination of these reflects well-being.

2.3. Interlinks between ecosystem services and human well-being

Human well-being has a vital relationship associated with ecosystems, and the benefits receive from them. The behaviour of human beings towards ecosystems is depends on how they perceive this relationship. The benefits received from ES accounts for one or more components of well-being (Butler & Oluoch-Kosura, 2006; Helka, 2016). Global studies on disasters by the World Bank (Dilley et al., 2005) strongly argues that abandonment or changes occurred to ecosystems leads to negative impacts on human well-being and communities are likely to suffer unduly. So, exploring the changes occurring to ecosystems is essential for a holistic understanding of interlinks between ES and human well-being (Ramirez-Gomez et al., 2015). Natural and anthropogenic are the two significant drivers of change, both act as direct (e.g., land-use change, management practices) or indirect drivers (climate, weather events) of change based on the situation. Seasonality (natural driver) is also an important dimension, interannual variability in the benefits received from ES has a significant impact on the transitory nature of human well-being (Leitão, Ferreira, & Ferreira, 2019; Pereira, Queiroz, Pereira, & Vicente, 2005). Such variations in ES benefits affects well-being. In addition, different people perceive the ES benefits differently, so how ES contributes to their wellbeing is also different. Many factors influence this variation, for example, a fisherman and a farmer perceive benefits from ES in different way, and this difference determines their behaviour towards ecosystems. So above mentioned variations and differences are often masked by current practices of measurements, which consider annual average measures of production and consumption as an indicator for well-being or growth (Dercon, Hoddinott, Krishnan, & Woldehanna, 2012). The idea of capability can be brought in to understand and differentiate how different stakeholders enjoy the benefit from ES.

In summary, the relationships between ecosystem services and human well-being is complex, multidimensional, and context dependent. Human well-being consists of material, and subjective dimension. The absence or change in ES is likely to affect well-being in different dimensions. In addition, the presence of anthropogenic assets (facilities, knowledge) and freedom of action and choice (supported by government institutions) also influences the perception of ES. In contrast, the conceptualisation of the interlinks between ES and Human well-being can be made by the identification and mapping of ES benefits to objective and subjective conditions of life (capabilities and functioning). It is also important to look at the changes to understand the scenario better. To untangle the complex interlinks between human well-being and ES, the perception of different stakeholders is essential because they are the active managers of ES (Maes et al., 2014). One among the experienced utility mentioned is human's aversion

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[16] There are different weighting standards suggested and used in many instances for example United Nation Human Development Report (HDR), it uses a methodology which gives higher weightage to some dimensions compared to others. Also, there is a stated preference method which assigns weights to different dimensions based on stakeholders' preferences.

towards nature, and it is stipulated in the biophilia hypothesis that contact with nature or environment is fundamental to the well-being of human beings (Tzoulas et al., 2007) It is important to look at different ecosystems and their contributions to well-being, how human's perception about the current state of ecosystems and their aspirations to the same contributes to the well-being.

In this study, stakeholders are the residents of the island, and the experts are the environmentalists, researchers, people from local self-government who are involved in similar research, policymaking, and governance. Pieces of literature and other documents collected to understand the social and environmental history of the study area, and it was crucial to operationalise the main aim of this study.

3. METHODOLOGY

This study followed a mixed-method approach (Alan Bryman, 2012). This study gave more emphasis on stakeholder identified issues and priorities. A structured methodology was used to identify key issues and adopted accordingly to respond to stakeholder priorities, at the same time, making sure that stakeholder's opinions were realistic. To triangulate results, findings from different methods were used. The primary source of data was the stakeholder interviews. Findings were compared with other sources of literature collected in the pre-analysis phase, pre-visit, and expert interviews at the end.

Participatory learning for action plans (PLA or PRA) is a methodological approach followed by many NGOs and government organizations to build common perspectives in both urban and rural development studies and projects (Ricaurte, Wantzen, Agudelo, Betancourt, & Jokela, 2014). This study adopted a similar methodology. However, due to the time constraints study did not go through all phases of PLA but completed the first three steps (Figure 6). The study started with a pre-analysis phase, which collected all available data to build first insights about the study area, its people, ecosystem, socio-economic conditions. This includes gathering information from all grey literature, social media posts etc. Next step was the pre-visit (in August 2019) to meet village leaders and some stakeholders, (residents of the island) and to get an idea about the study area. During this period, information about livelihood activities, ecosystems, and activities inside the island were identified and recorded. The third phase (fieldwork phase) was the semi-structured interviews with the stakeholders and the experts. Data collected in the last phase considered as the primary data. Analysis, discussions, and conclusions are primarily based on this data.
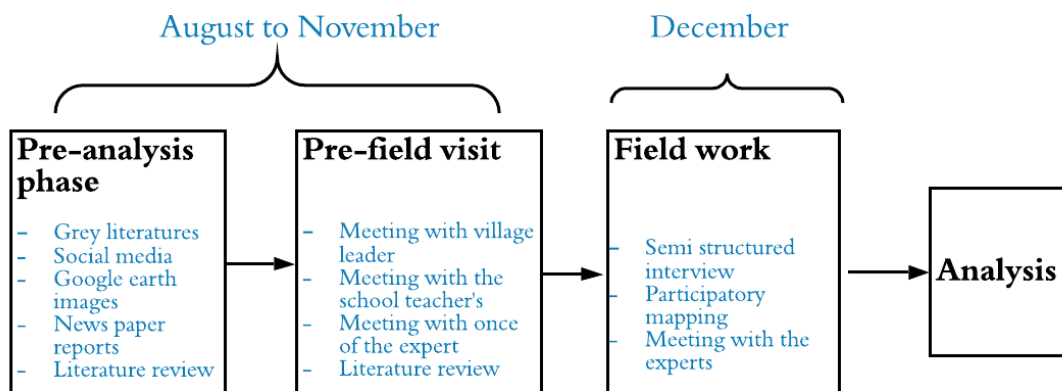
Figure 6 Fieldwork and pre-fieldwork phase

Primary data was collected during the first to the fourth week of December 2019, 130 semi-structured interviews were conducted during that period. A participatory mapping exercise was conducted along with the semi-structured interviews.

3.1.1. Pre-analysis phase

This process was done in august 2019 to understand the study area and to prepare the research design (divided in to two parts). Part one, during this period, many grey unpublished pieces of literature were reviewed to understand the study area. Part two, published and peer-reviewed research papers, was reviewed to explore the relationships between ecosystem services and human well-being. Even though not many studies have been done, part one of pre-analysis phase was mostly depended on fieldwork diaries of a researcher[17], one research paper, Google earth images, newspaper reports and few Facebook posts and tweets. Description of the study area was prepared based on the above-mentioned items. All these have been used in the discussions section. Peer-reviewed literature is described in the literature review section.

3.2. Pre-field visit phase

Due to the lack of studies and published works on the selected study area, an informal visit to the island had to be made to gather more information about the study area. This visit was made with the help of a professor from KRVIA, Sandeep Menon in August 2019 (Table 1). The primary purpose of this visit was to meet the stakeholders' and to build a proper understanding of the study area. During this visit, we met the sarpanch (Village leader), previous sarpanch (EX- Village leader) and one resident of the island. These meetings helped to understand the history (both social and environmental), and the socio-economic conditions. List of ecosystem services and well-being indicators were finalized based on the inputs received from these meetings. Due to the informal nature of visits, these meetings were not recorded using the voice recorder. However, photos and handwritten notes were used instead.

3.2.1. Site selection

During the pre-field visit time, there were three sites in consideration, and these three had unique ecological and cultural characteristics. A preliminary visit was made to two of them (Pachu Bandar and Panju island). The two sites had one thing in common, it is the pressure from the urban expansion, due to its peri-urban geographical location. The first visit was to Pachu Bandar in Vasai. It is a coastal fishing village situated in the mouth of Vasai creek facing the Arabian sea. Primarily a fishing community. The second one was the Panju island, situated in the Vasai creek. The third, an inland peri-urban area, Diva, often referred to as an 'Island on the land' due to inefficient/convoluted road connectivity. It is a dense urban settlement primarily developed on both sides of the Diva Junction railway station (offering connections to the suburban rail network of Mumbai), flanked by wetlands, rivers on the north, south and west. Out of these, Panju island was chosen because of its stakeholders' and culture, the stakeholders had a season-based occupation pattern and is situated in between two municipalities, yet not urbanized due to its locational peculiarities[18]. This characteristic made the Panju island interesting and suitable for the case study (Yin, 2009). The other two sites did not have any noticeable interactions with the local ecosystems, geographically located in places with less pressure from the urban area.

3.3. Sampling design

Based on the information collected during the pre-field visit, a sampling design was prepared, which suits the local characteristics and to gather sufficient relevant information for this study. Census data was used

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[17] Ankita Bhakthkande from Tata Institute of Social Sciences (TISS), now working as a reporter in Hindustan times newspaper

[18] More details can be found in description about study area in introduction section.

to determine the quota (quota sampling to determine the number of males and female respondents). The sample is representative of the total population. The number of semi-structured interviews was determined based on the total population (With 95% confidence level, and margin of error 10%) (Ranjit, 2011). In the sample population, 55.6% are male, and 44.4 % female. As per the census, the study area has 52.7% male and 47.3% female. So, it is comparable to the actual population.

3.3.1. Sampling design: Stakeholders

The sample size was estimated to 90 with a 95% confidence level and confidence interval of 10 (considering the total population is 1358 according to census) . However, to avoid issues with no data and possible uncertainties with the quality of data, a total of 130 semi-structured interviews were taken. Out of that, only 108 was used for this study due to multiple reasons like unexpected responses[19]. The sampling units were people who are older than 15. Elderly was chosen consciously to make the sample heterogenous. The approach had mixed sampling design. The first stage was random, and the other was non-random. Approximate location of houses was decided randomly with the grid created on the satellite image from Google Earth (Figure 6). However, a purposeful non-random method (quota) was chosen to include women and the elderly to avoid bias in the data.

The mixed sampling strategy includes a simple random choice of houses in the village and quota sampling of respondents. Women, the elderly was chosen consciously. A simple random sampling of houses was selected with a grid placed on top of the satellite imagery of the study area. Twenty-one random cells were selected (Figure 7); one or more houses was selected from each block [20] (Figure 8). Standard methodologies for choosing houses was not applicable in the study area[21]. So, the choice of houses was random (choice of houses inside the grid) (in total 130 houses were selected, and interviews were conducted at the selected houses (Figure 8)).

Also, there was one more consideration, and it is based on the observations made during the first visits and pilot interviews. The type of residents in the study area had a spatial pattern, rich and native people live in around the temple and public amenities, and new migrant people are pushed to the outskirts without access to the public amenities. So, a purposive sampling (N=5) was done to include migrant workers in the study population (this information is not available in the census data).

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[19] Responses with no logic, incomplete responses, refused to answer or said no opinion for most of the questions.
[20] Due to the specific design of houses in the study area a single block includes more than 2 houses. It is hard to delineate boundaries of individual houses; this was also the reason behind visualizing the sampled houses as polygons instead of points.
[21] The houses inside study area was constructed on non-motorable narrow streets. So, sampling strategies like choosing alternative buildings was not practical.
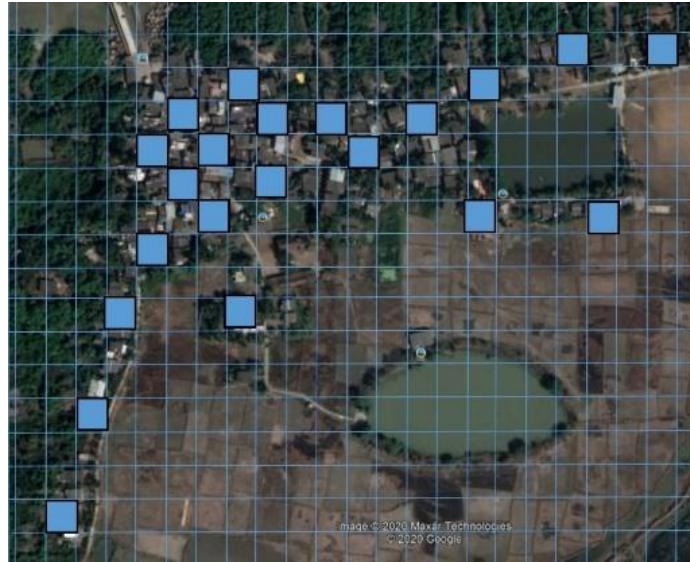
Figure 7 Sampling grid used for data collection
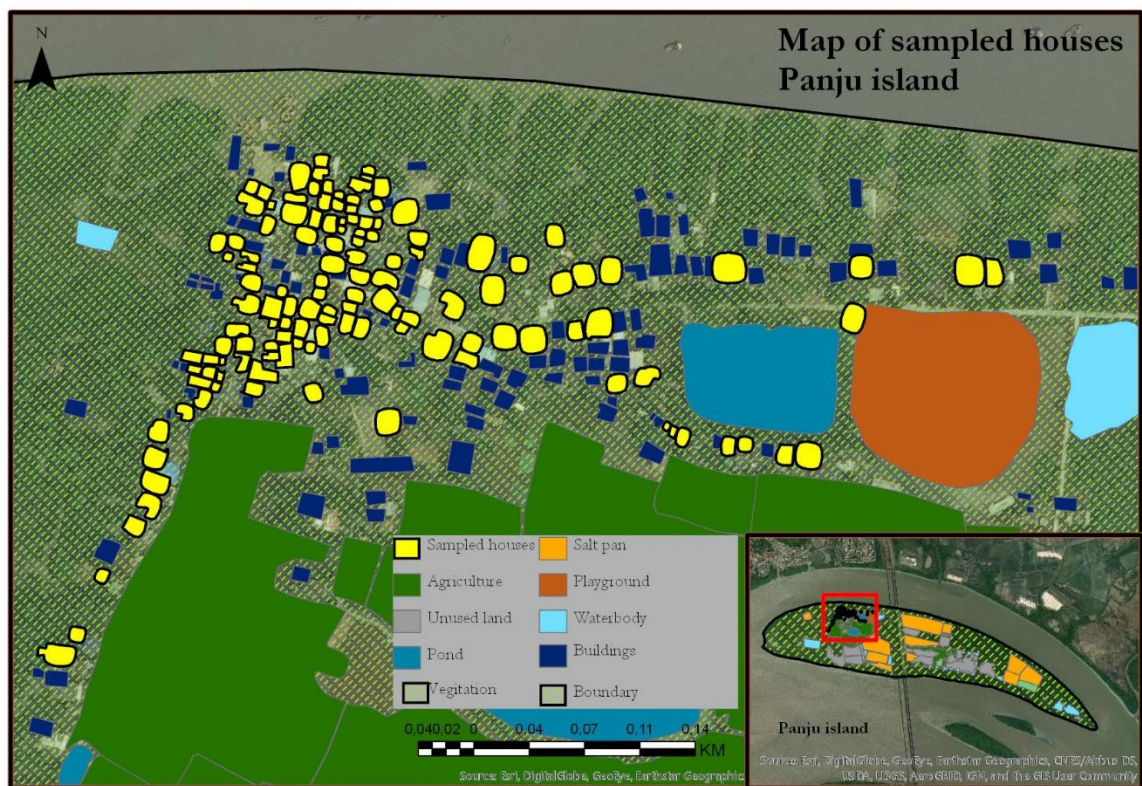
Figure 8 Map of sampled houses in Panju island

3.3.2. Sampling design: Experts

The remote nature of the island made finding experts challenging. Not many studies were conducted in the study area; for the same reason, many experts I approached refused to participate in the interview process. The list and details of all experts responded is given in Table 1, Except Sandeep Menon all others were traced and contacted with the help of grey literature and social media. For example, one of the experts Ankita was found with a location-based tweet search (location: Naigaon). The same applicable for Kiran Bhoir.

Table 1 Experts who contributed to this study by participating in the expert interviews

Name of the expert and affiliation	Expertise	Familiarity with the study area
Sandeep Menon (KRVIA, Mumbai)	Planning, Ecology, and ecosystems,	Conducted research on the ecology, ecosystems as part of the BreUCom project.
Ankita Bhakthkande (Times of India)	Social worker and a media person,	Conducted field studies on the island. Wrote two newspaper articles about the people and life on Panju island.
Ajay Khample (Bhavans College, Mumbai)	Geomorphology, tourism	Published a research paper on estuarine islands of Mumbai, which includes Panju also.
Kiran Bhoir (KMC holidays, Mumbai)	Tourism	Born and brought up in Panju island, Own a tour planning company in Vasai. Enthusiast and very much passionate about the tourism and recreational potential of the island.
Ashish Bhoir	Village leader	Villager leader (Sarpanch)

Interviews were conducted over social media, email, and over the phone call. In the case of Kiran Bhoir and Ashish Bhoir, an informal discussion was conducted. The handwritten notes taken during the discussion was used in the study.

3.4.   Research design

Figure 9 explains the overall flow of the research. Research questions were formulated with the help of literature and experts on the field. The primary data collection was done using semi-structured interviews along with participatory GIS mapping exercise (PGIS) (Annex 8.4 & 8.6). Three different kinds of data were collected, quantitative (likert scales), two, qualitative (open-ended questions, descriptions) and PGIS. All these were used for addressing different research questions. Crowdsourced data mentioned in the diagram stands for social media posts (From Facebook and twitter) collected through a location-based search for verification of phenomena explained by the experts and the stakeholders through a place-specific search.
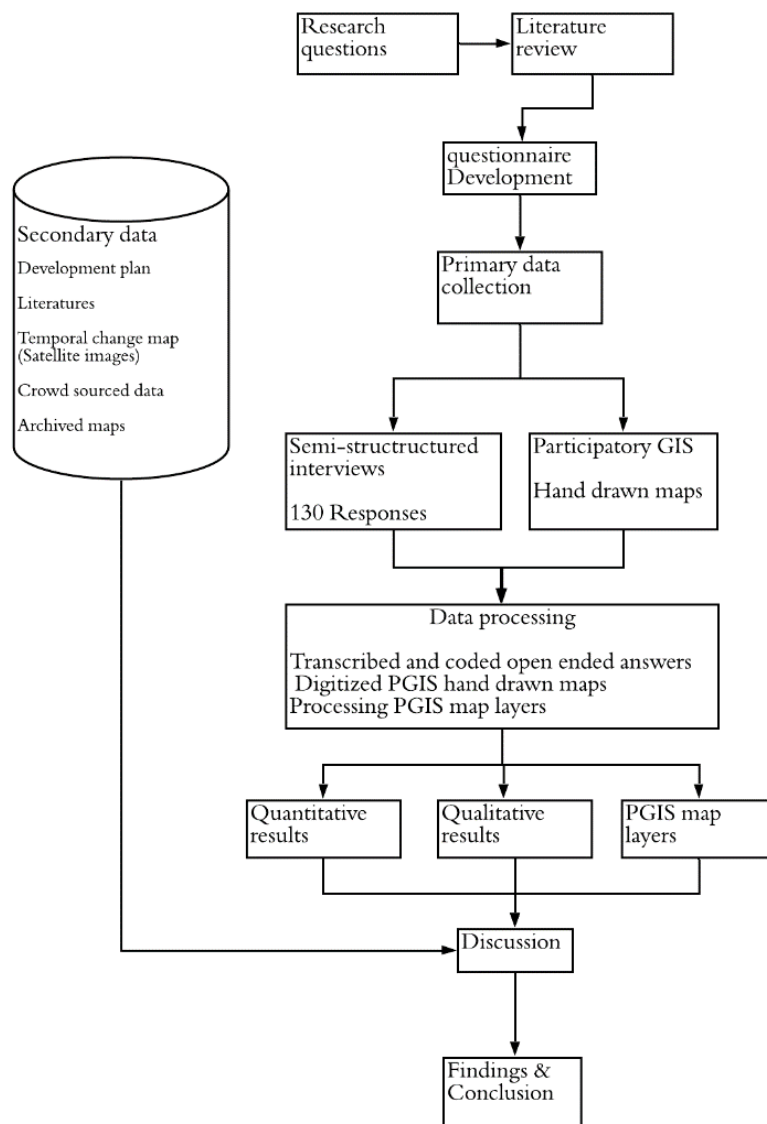
Figure 9 Overall research flow

3.5.   Research matrix

This section includes the research matrix, which explains different research questions; the methods are chosen to address it and expected results.

Table 2 Table explaining methods and expected results for each research questions.

Research questions	Methods	Expected results
1) To understand the essential aspects of well-being as perceived by stakeholders (stakeholders and experts).		
1a. What are the material (objective) conditions of well-being essential for the well-being of stakeholders?	Quantitative and qualitative analysis: grounded theory	Stakeholders (objective) perception of different material well-being conditions (basic materials for a good life).
1b. What are the subjective (Non-material) elements of well-being essential for the well-being of stakeholders?	Quantitative	Stakeholders perception (subjective) on the different quality of life conditions. (perceived security, health, social relations)
2) To understand stakeholder's perception about the benefits received from provisioning, cultural and regulating ecosystem services.		
2a) What benefits do stakeholders receive from nature?	Quantitative and qualitative	Stakeholders perception of different benefits received from ES. (provisioning ES, cultural ES and regulating ES)
2b) According to stakeholders, where is the provisioning, cultural and regulating ecosystem services located?	PGIS Qualitative analysis: grounded theory	Location of different ecosystem services mentioned in 2a.
2c) Do stakeholders perceive that the benefits received from ES changed? If so, what changed according to stakeholders?	Quantitative and qualitative analysis: grounded theory Participatory GIS	Changes happened in the flow and demand, and this research question answers where which way and why? It is combined with Participatory GIS; it explores Natural and anthropogenic drivers of change and locations of change occurred and spatial differences in perception among stakeholders.
2d) If the stakeholders perceive the benefits received from the ES changed, what are the drivers of change according to stakeholders?	Qualitative analysis: grounded theory	Perception of stakeholders about drivers of change. (natural and anthropogenic drivers of change)
2e) Do the ES benefits vary in different seasons? If so, what is the variation in benefits received according to stakeholders?	Qualitative	Seasonal variation in ES benefits
2f) Are there differences in	Qualitative analysis: grounded theory	Change in perspective between

perception between stakeholders about the benefits received, changes and drivers of change? If so, in which aspects?		stakeholders', and this explores the freedom of choice and the influence of anthropogenic assets.
3) To analyse which ecosystem services are crucial for well-being in stakeholder's perspective.		
3a) Which ecosystem services are crucial for the well-being of the stakeholders?	Quantitative and qualitative analysis: Grounded theory	Information on different ecosystem services and their contributions to different components of well-being.
3b) What are the differences when comparing, the views of the experts on available ecosystem services with the perception of stakeholders?	Quantitative and qualitative analysis: grounded theory	Insights on the real situation. (triangulation)
4) To understand how ecosystem service information can be operationalized to enhance well-being at the local level.		
4a) How the to integrate ecosystem service information in policy responses and local decision-making process	Literature review, and analysis of findings	Policy responses and opportunities for enhancing well-being based on the information collected.
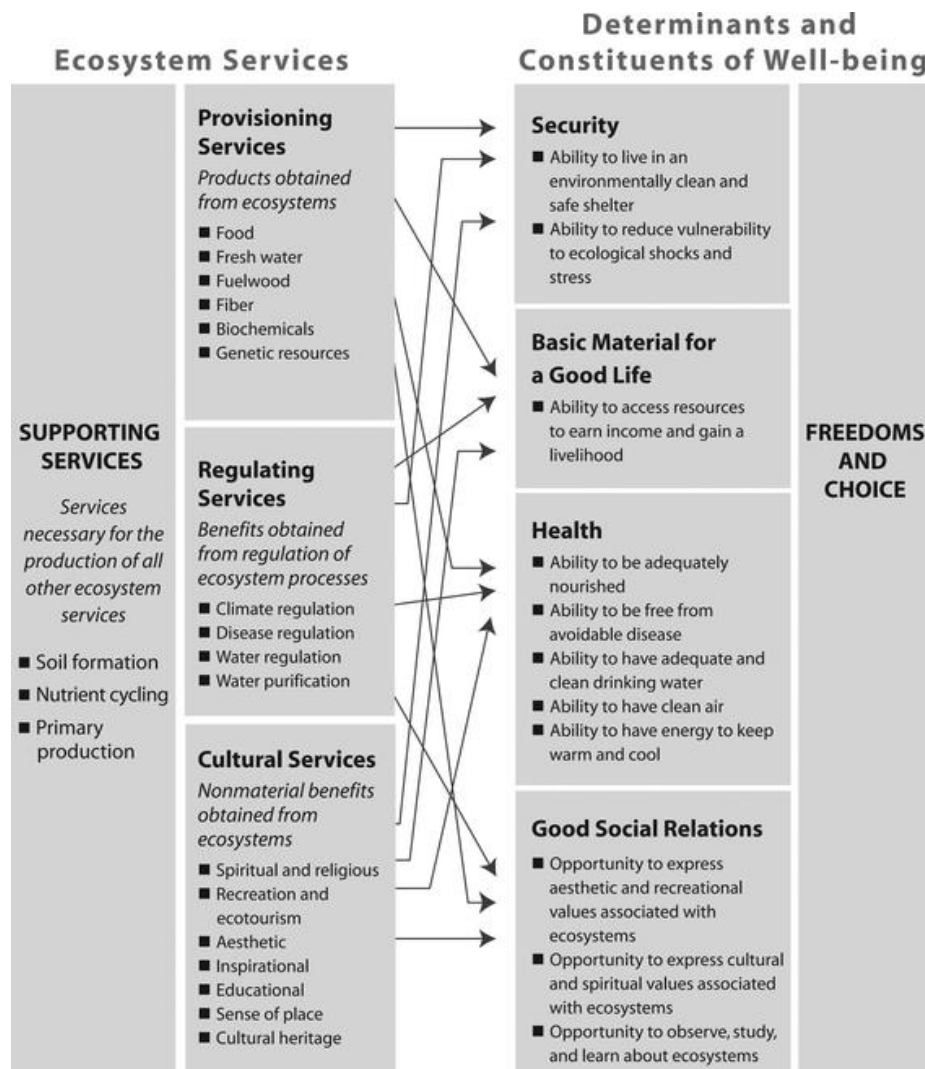
Figure 10 Millennium ecosystem services framework. Source MEA 2005

The framework by the millennium ecosystems services assessment is used extensively in this study (Figure 10). However, this study has a slightly different focus, and only the dimensions were adopted to this study directly (except security was replaced with safety). The indicators are chosen separately by consulting the experts (Table 3) and the local criteria.

3.6. Identification and finalization of indicators

Table 3 Dimension and attributes for well-being indicators

Sub-dimensions	Attributes/Indicator	References
Basic materials for a good life (Dimension-objective conditions of wellbeing)	• Education	(Gasper, 2007)
	• Income	("Urban Development - OECD," n.d.)
	• Skill	(OECD & The World Bank, 2013)
	• Access to food and water	(FAO, 2017)
Health (Dimension-subjective conditions of wellbeing)	• Visitation to doctor	(Vander Elst, van den Broeck, de Witte, & de Cuyper, 2012) (Kim, Park, Sun, Smith, & Peterson, 2014)
	• Reason behind visitation	(Kim et al., 2014)
	• Quality and quantity of water	(Li & Wu, 2019)
Safety (subjective conditions of wellbeing)	*Perceived safety (disasters: Flood)* • The general perception of safety from natural disasters	(United Nations Development Programme, 2019)
	• Perception about personal safety with respect to the livelihood activities	(United Nations Development Programme, 2019)
Good social relations (Dimension-subjective conditions of wellbeing)	*Social cohesion and participation* • Relationship with others	(United Nations Development Programme, 2019)
	• Participation in Gram-Sabha (local body meetings)	(United Nations Development Programme, 2019)
	• Sense of place	
Freedom of choice and action (Dimension-subjective conditions of wellbeing)	• Participation in the decision-making process	(United Nations Development Programme, 2019)
	• Ability to raise concerns and voices	

The dimensions and sub-dimensions are adapted from the IPBES and Millennium ecosystem service assessment frameworks. However, the capability approach has influenced the choice of the indicators, but finalization was done after the inputs from the experts on the field and the observations during the fieldwork. These indicators combined explains the well-being at an individual and community level. A description of each indicator is given in the next section. All the indicators are measured at an individual level. The choice analysing them (at an individual level or community level) is based on the research questions.

3.6.1. Dimension – objective wellbeing conditions

Material well-being explores different material (objective characteristics). Indicators of these dimensions define the capacity of the sample population to achieve well-being. Association of different ecosystem services to different capabilities is also explored.

Indicator: Education - Highest education level obtained. studies show that higher education level shows a higher correlation with better, mental, physical, and emotional well-being (Gasper, 2007).

Indicator: Income level - Monthly household income defines material standards. It is a capability which supports other non-material well-being dimensions, thereby helping the individual to achieve functioning. For example, income is required to achieve better education and better health care (Urban Development - OECD, 2016).

Indicator: Skill - Here, the current occupation of the respondent is considered as a proxy to skill level. Uncertainties and overestimations can be avoided with comparisons with education level. Skill possessed by different individuals is a fundamental determinant of well-being. This gives an idea about interventions required (OECD & The World Bank, 2013).

Indicator: Access to food and water - Food and water are the necessities of any living animal on earth. Access and adequate availability of them are important for the material well-being. This indicator measures do the stakeholders have enough access to food and water.

3.6.2. Dimension – subjective well-being.

Subjective wellbeing explores stakeholders' perception of different subjective conditions of life. In general, this measure achieved well-being (functioning). The indicator also measures how different ES has contributed to their achieved wellbeing.

3.6.2.1. Sub-dimension - Health

The three indicators below explain their achieved health condition. Visitation to the doctor, and the reason behind the visitation gives enough information to draw the relationship between ES and health.

Indicator: Visitation to the doctor - Indicator measures how many times the stakeholder visited the doctor in the last three months. Vander Elst suggests that number of visitations to the doctor is positively associated with health-related issues (Vander Elst et al., 2012). Vander's study is based on a psychometric evaluation of well-being indicators. Here, this study considers the same observation as a proxy to understand underlying health issues and their causes. These mentioned health conditions and causes were them connected linked to different ES.

Indicator: Reason behind visitation - The reason behind visitation to doctor is explored to identify possible interlinks with ecosystem services.

Indicator: Access, quality, and quantity of water – This indicator was chosen based on assumptions made during the field visit. It is a subjective evaluation of access to freshwater, quality of fresh water and quantity.

3.6.2.2.   Sub-Dimension – Safety

Due to the remote and geographical characteristics, safety from natural disasters (flood) and safe access and availability of livelihood activities required for wellbeing. This indicator also explores ES which influences that perception

Indicator: The general perception of safety - Generalized perceptions about safety from flood, and the feeling of safety from access to livelihood activities were observed. Many factors influence this perception, one past incident, two the feeling of safety because of the presence of an ecosystem (mangrove) or other human-made infrastructure.

Indicator: Perception about future safety from natural disasters - This indicator measures the perception of future safety. Are they afraid of anything which may happen in the future? The responses were marked on a Likert scale, and explanations were also explored.

Indicator: Perception about personal safety with respect to the livelihood activities - Indirect observation [22] about safety with respect to their livelihood activities were explored. Qualitative information's collected used to arrive at assumptions. In terms of livelihood, presence, and un-interrupted supply of certain ecosystem service can contribute to the perception

3.6.2.3.   Sub - dimension - Good social relations

Indicator: Relationship with others - Relationship with other members of society represents solidarity. Relationship with others is gauged by recording their perceptions about a good social relationship with the neighbours and their willingness to collaborate for the common good.

Indicator: Participation in Gram-Sabha (local body meeting) - Participation in meetings organized by local self-governments. Participation in these activities not only explains social cohesion but also accessibility and opportunities in the decision-making process. However, here in this study, it is considered as a proxy for social cohesion. Because mere participation in the Gram-Sabha (local body meetings) does not mean the individual is participating in the decision-making process.

Indicator: Sense of place - This indicator measures the attachment of the individual to the community. Measured with two indicators, exploring their willingness to stay at the study, and the motivation behind. This indicator explores socio, cultural and environmental variables which influences the perception about the sense of place.

3.6.2.4.   Sub - dimension – Freedom of choice and action

Measurement of freedom of choice and action is important. One, to know what influences the difference in perception among different respondent groups. Two, to estimate how democratic the decision-making process is, in the study area. One of the influencing factors is the dependency on natural resources (ES), stakeholders' who are involved in activities within the island (for example agriculture, fishing) will perceive more involvement in the decision-making process because of the increased social cohesion.

Indicator: Participation in the decision-making process - Participation in decision-making process represents the ability of an individual to raise voice and have control over what is happening. This stands as a proxy to gauge how democratic the local decision-making process is.

Indicator: Ability to raise concerns and voices - Participation in the local decision-making process does not mean that the voices are heard. A detailed indicator is required to understand whether their concerns are heard or not.

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[22] Concerns because of loss in agricultural land. Due to various direct and indirect drivers.

3.6.3.   Dimensions of ecosystem services.

The dimensions of ecosystem services are adapted from the millennium ecosystem service assessment, but the final compiled list was prepared after the field observations. This list was then used to identify priority ecosystem services

Table 4 Dimension and attributes for different ecosystem services

Ecosystem services	Attribute/indicator
Provisioning	*Collection or presence of the following ecosystem services* • Hunting prays • Gathering/ picking up goods • Fishing • Seafood • Timber • Fuel / wood • Medicinal & cosmetic plants • Livestock • Agriculture production • Aquaculture • Freshwater • Fibre crops • Tree plantations
Cultural	*Presence of the following values assigned to different ecosystem services.* • Tourism/Ecotourism • Landscape beauty • Education / interpretation • Scientific research • Traditional Ecological Knowledge • Sense of place • Cultural heritage • Religious / spiritual
Regulating	*Ecosystem services with the following functionalities.* • Soil retention & Erosion control • Hydrological regulation • Pollination for useful plants • Climate regulation • Soil purification • Waste treatment • Water purification • Flood buffering • Pest prevention • Invasive species prevention • Air quality • Habitat maintenance • Food web maintenance • Nursery • Saline equilibrium • Climate regulation

3.7. Anticipated results

This section includes the anticipated relationship, which can be found between different ecosystem services and human well-being dimensions (Table 4). Anticipated ecosystem service dependency describes direct or indirect observations. Anticipated influences are how the dependency influences the well-being dimension.

Table 5 Ecosystem service dependency and influences

Sub-dimensions	Anticipated ecosystem dependency	Anticipated influences
Basic materials for good live (objective conditions of well-being)	Livelihood activities depend on ES provision. Basic necessities like food and water are dependent on local ecosystems.	Changes in ES provisions have affected the material well-being in the study area.
Health (subjective conditions of well-being)	Microclimatic regulation, regulating services for fresh air and water.	Presence of ES functions contribute to the dimension of health
Safety (subjective conditions of well-being)	Ecosystem services provide safety from extreme weather events. Ecosystem services proving a sustainable livelihood	Presence of mangroves and other ecosystems contribute to the perception of safety
Good social relations (subjective conditions of well-being)	Cultural ecosystem services increase social cohesion. Alternatively, ecosystem service influenced social cohesion.	Cultural activities and recreational activities related to the presence of ES contributes to good social relations
Freedom of choice and action (subjective conditions of well-being)	Cultural ecosystem services increase social cohesion. Alternatively, ecosystem service influenced social cohesion leads to more freedom of choice and action	Same as the above

3.8. Fieldwork

Planned fieldwork activities were semi-structured interviews, expert interviews, and visits to the government offices for secondary data. Due to unforeseen circumstances (political unrest due to Citizenship Amendment Bill (CAB) in India and corona outbreak) only the semi-structured interviews went as per the planned schedule, and compromises had to be made in the meetings and visits scheduled to TISS and IIT Mumbai. Fieldwork started with finding research assistants and pilot interviews, challenges faced, and solutions developed are mentioned in the following sections. To make the data collection process easier, I used Kobo toolbox[23].

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[23] https://www.kobotoolbox.org/

3.8.1. Questionnaire design

The questionnaires were designed in a way it addresses all research questions. Data regarding demographic characteristics, and their perception about different ecosystem services, changes happened over time, willingness to make changes was recorded. The questionnaire had 89 variables, divided into seven sections. The questionnaire is designed aligning with the subdimensions of wellbeing, ES dependency to each was gathered through explanations given during each dimension and during the participatory GIS exercise. A detailed description of challenges faced during the semi structured interview process is included in the annexe (Annexe 8.11)

Table 6 Questionnaire sections and description

Section	Description
Section 1 **(Basic materials for a good life)**	Includes basic characteristics of stakeholders,
Section 2 **(Basic materials for a good life)**	Includes livelihood activities and seasonal change
Section 3 **(Health)**	Includes health
Section 4 **(Safety, Good social relations)**	Includes the perception of stakeholders about different subjective conditions
Section 5 **(Health: but did not use in this study)**	Includes sanitation-related information
Section 6 **(Good social relations)**	Freedom of choice, Participation, and social cohesion
Section 7 **(Basic materials for a good life, safety)**	Mangrove

3.8.2. Interview guide

Interview guide for the experts (Annexe:8.5)

The interview guide prepared and followed had three sections, primary aim of the interview guide was to verify the information provided by the stakeholders and to find the difference between experts and the stakeholders.

Section 1

> General questions, asking the experts to explain about their area of interest and expertise, involvement in similar projects and how do they define ecosystem service.

Section 2

Ecosystem services. This question is aimed at exploring expert knowledge about the ecosystem services available in the study area. Also, this section asks the experts to prioritize ecosystem services in the study area and based on their logic and expertise.

Section 3

Well-being. This section explores their perception about the well-being of the community

3.9.   Participatory GIS

Participatory mapping tools, such as participatory geographic information system techniques have been proven as an effective tool for data generation and improved management of natural resources (Isabel Preto, Michael K. McCall, Mário Freitas, & Luís Dourado, 2016; Rambaldi, Kyem, McCall, & Weiner, 2006; Wei et al., 2017). It helps the communication process between the authorities and the local stakeholders', because of 2 reasons, one, the map is created is with inputs from stakeholders, so it makes the communication process easier. Two, it is more relevant and more informative compared to official maps which are based on secondary information (Ramirez-Gomez et al., 2015). A short participatory mapping exercise was conducted along with the semi-structured interviews. Purpose of this exercise was exploring the geographical distribution of different ES and the values assigned to them by the stakeholders. PGIS exercise gathered information to address objective 2b 2c,2f.

A printed digitised study area map along with satellite images (as a reference) was used for the participatory mapping exercise (See Annexe: PGIS exercise 8.6 for the map used for participatory mapping exercise and sample response).

The PGIS exercise included two sections, one getting the respondent familiarised with the study area map. The second is to mark their responses. Few questions in the questionnaire had a spatial element to it, for such questions a code was given for example p1, p2, p3. The markings were as a hand-drawn polygon on the PGIS map, and the code was written inside it. In addition to that, the PGIS map included a list of ecosystem services in the map (the list was compiled with the inputs received from the stakeholders and the experts during the pilot interviews), a general question was asked at the end of section 3 (of the questionnaire) to identify the benefits mentioned in the list. This response was also included in the PGIS map with pre-defined codes.

The intensity map was prepared by digitization and analysis of the PGIS maps in ArcGIS Pro (Figure 11). The digitized polygons were cleaned, and edges were smoothened with smooth polygon tool to make the polygons visually appealing. Another cleaning process was also done to remove wrong digitization's and polygons without complete information. Later a tessellation was created (2500 square meter area), the size was decided based on the approximate area of the smallest digitized polygon. The digitized polygons were then joined to the tessellation. The Intensity map was prepared with merge rule of count (count of the number of stakeholders mentioned about. The map of ecosystem service was prepared with merge rule of max (maximum) which shows which is the most mentioned ecosystem service in at that area.
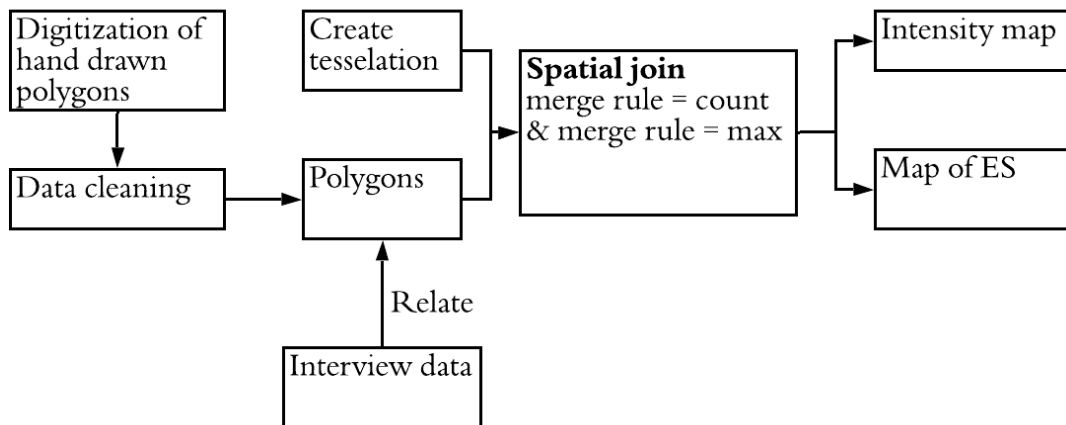
Figure 11 Methodology followed for PGIS analysis

3.10.   Data collection: Semi-structured interviews.

The semi-structured interviews were conducted by the researcher with the help of research assistants[24] (to translate the Marathi language). In total, 130 semi-structured interviews were conducted in households (see Figure 12 for detailed information on sample population). The semi-structured interviews were conducted in mornings 8 AM to 10 AM and in the evening 4 PM to 6 PM or in in the weekends, the timings were fixed based on three factors, maximum availability of stakeholders' in the island, and availability of boat transport.
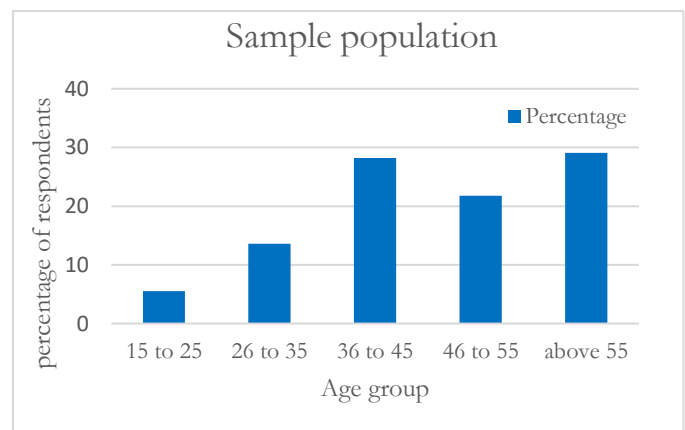
Figure 12 sample population: Age groups

3.11.   Coding and validation

All answers to the open-ended questions were coded using Atlas.ti software. As the first step noise from the data was removed, all statements which are not relevant was removed and brought all information to the same format. Total of 16 such documents (based on 16 different open-ended questions) was created for different sections of a semi-structured interview. As most of the open-ended questions were exploring what happened to different ES provisioning area (Except one explaining requirements), a similar coding scheme was followed (Awareness, changes, positive benefits,
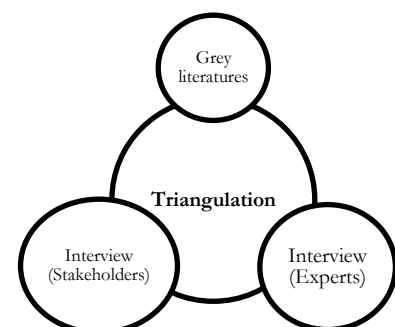
Figure 13 Triangulation

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[24] Selected research assistants from the same locality

negative benefits, and the drivers of change). All the claims made by the grey literature, stakeholders and the experts mentioned in the results and discussions section was validated and checked reliability by triangulation (Figure 13).

3.12.   Ethical consideration

As this study involves data collection from the residents of the study area, three ethical considerations will be followed. One; the researcher will orally explain the aim and objective to the respondents. Second, the researcher will seek oral consent of the respondents. Three, the researcher will explain the potential consequences to the community once the information is collected (if there is any), analysed and reported. The research ensures the protection of the respondents' confidentiality, privacy. The respondents will be treated anonymously and equally (No form of differentiation will be shown based on age; gender; race; ethnicity; national origin; religion; sexual orientation; disability; health conditions; or marital, domestic, or parental status).

4.   RESULTS

This chapter presents the findings of this case study, with regard to the objectives and research questions mentioned in the introduction chapter. The chapter has three sections. One includes findings on the well-being aspects which describe the objective and subjective conditions of well-being in Panju island. Subsection 4.2 includes ecosystem services benefits. The last section includes information on the interlinks between ecosystem services and human well-being. Throughout the results section, stakeholders are the residents of the island, all the generalisable findings and arguments are addressed to stakeholders. The sample population is the stakeholders who responded in the semi-structured interview process.

4.1.   Well-being

The following sections describe different well-being dimensions and establish its relationship with different ES in the study area.

This section addresses objective one, an assessment of essential aspects of wellbeing as perceived by the stakeholders. The objective wellbeing part investigates material aspects of wellbeing as well as the capabilities which will lead to "functioning" (well-being). The subjective wellbeing sector explores the stakeholder's perception of different subjective aspects of wellbeing.

4.1.1.   Objective conditions of well-being

Objective conditions of well-being include the material aspects, which are directly measurable. Indicators chosen are income level, education, skill level, access to water and food. Objective conditions, in general, describes the capabilities of stakeholders to achieve functioning. In addition to that, some ecosystem services like the provisioning support the capability. For example, provisioning ecosystems like the saltpans, agricultural land contribute the income indicator.

4.1.1.1.   Income

Income level was coded into five levels starting from 1000 to above 50000 (Figure 14). More than 50 per cent of the sample population belongs to the 10000 INR (120 Euro) to 20000 INR (220 Euro) per month income level (per household), and 35 per cent belong to 1000 to 10000 income level. The mode is 2 (2 = 10001 INR to 20000 INR) (Figure 14))and standard deviation 0.86, and this implies that majority of sample population belongs to the economically weaker section (Figure 14) (Indian Economic Service : Government of India, 2012). When compared with the threshold set by the government of India (Prime Minister Awaz Yojana defines household with annual income less than 300000 INR (3529 Euros) as EWS) (MHoUPA, 2015), 85 per cent of the sample population belongs to the economically weaker section (EWS). Few respondents mentioned that there had been a considerable decrease in the income level when they had to stop sand mining, saltpan works, due to government regulations.
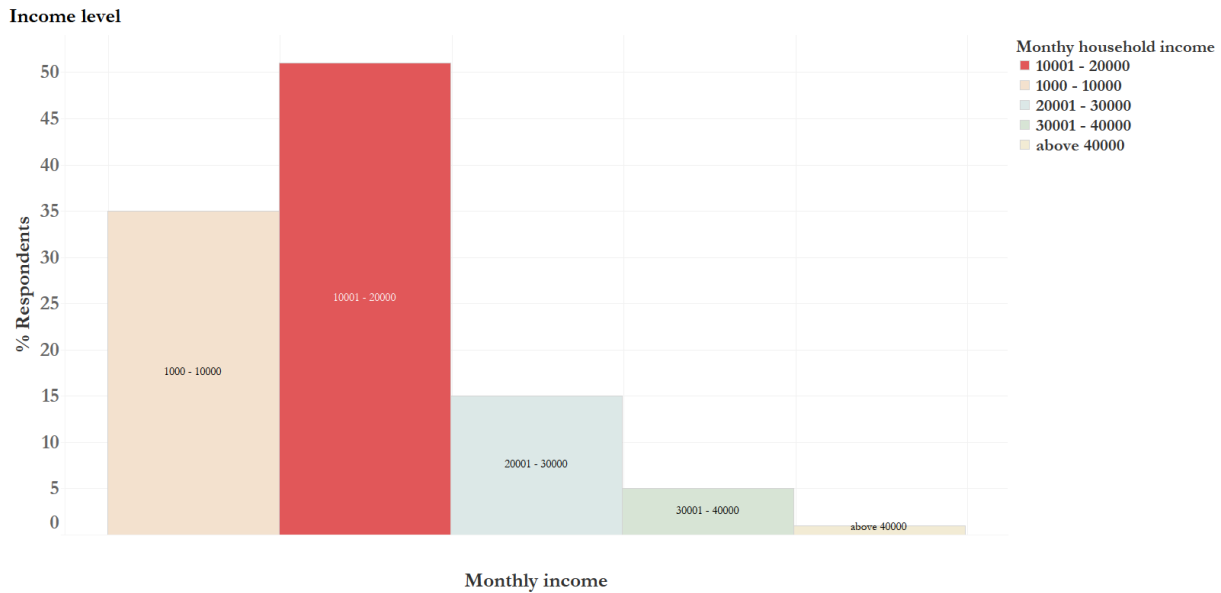
Figure 14 Income level

Table 7 Descriptive statistics, income, education, and skill level

Descriptive Statistics						
	N	**Minimum**	**Maximum**	**Mode**	**Std. Deviation**	**Skewness**
Income **1 = 1000 to 10000** **2 = 10001 to 20000** **3 = 20001 to 30000** **4 = 30001 to 40000** **5 = above 40000**	108	1	5	2	0.861	0.949
Education **1 = lower primary** **2= Upper primary** **3 = High school** **4= Higher secondary** **5 = Graduation**	108	1	5	2	1.297	0.614
Occupation **Refer to the next section.**	108	1	4	1	0.781	1.12

This income also varies between different seasons. Various factors affect them (Figure 15). When the responses were aggregated, spring and winter is the time where stakeholders receive higher incomes. When enquired the reason behind this variation, there were two types of reasons: one, ecosystem service flow, which is the availability of fish, the ability to do agriculture (Text). Two is the safety issues; stakeholders cannot go to work for many days in monsoon, as travelling by boat is not considered as safe[25].

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[25] There has been a series of boat accident histories. https://www.mid-day.com/articles/mumbai-boat-carrying-marriage-party-capsizes-1-dead/16996193

Stakeholder (Farmer): "Agriculture harvest varies in different seasons and years as well"

*Stakeholder: "The seasonal barriers don't allow going in the sea much,
monsoons and bad whether prevents us from going out of the island"*

Text box 1 Seasonal variation in income
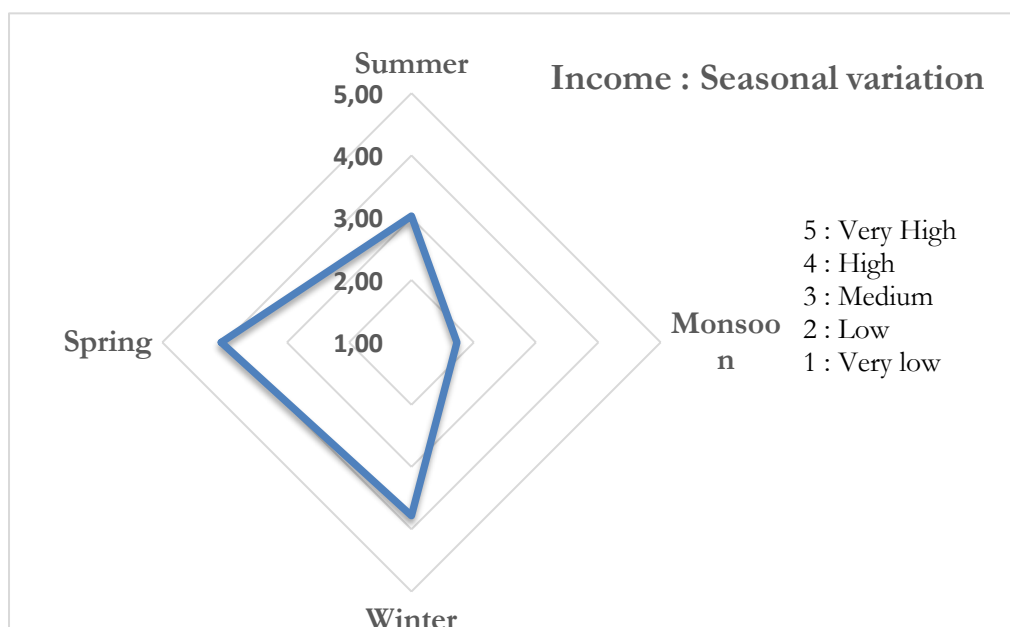
Figure 15 Seasonal variation in income

4.1.1.2. Education

The education levels of respondents were classified into five categories, starting from the lower primary (Below 5th grade), upper primary (between 5th grade and 8th grade), high school (between 8th grade and 10th grade), higher secondary (between 10th grade and 12th grade), graduate (above 12th grade, including vocational training after 12th grade) (Figure 16). The sample population is 100% literate. 44 percentage of the sample population had completed the upper primary level of education. When compared with the state (Maharashtra - 82.34 %) and national (74.4%) census statistics, literacy rate of Panju island is higher 83.03 (Government of India, 2011,census). In that case, the literacy rate of the sample population is a little higher (100%). Mode of education level is 2 (upper primary), and the standard deviation is 1.29 (Table 7). This means most of the sample population has education level less than or equal to high school.

62 % of the sample population has only been able to obtain education below high school (10th grade) (Figure 15) The reason behind is access to education, the school inside the island only offers education till high school.
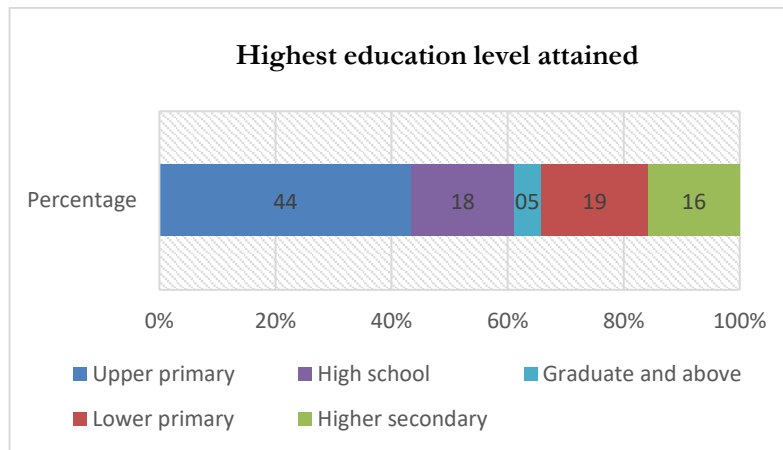
Figure 16 Percentage of stakeholders' and education level.

Figure 18 explains the same fact and gives more clarity to it. It explains the same trend of dropping out of school after the high school level is being followed in the newer generation. Referring to the explanations given by Amartya Sen, Higher education can be considered as a proxy to obtain a better quality of life (capability and functioning) (Heckman & Corbin, 2016). At the same time, it is also important to notice that the majority of the stakeholders are literate and has upper primary level education.
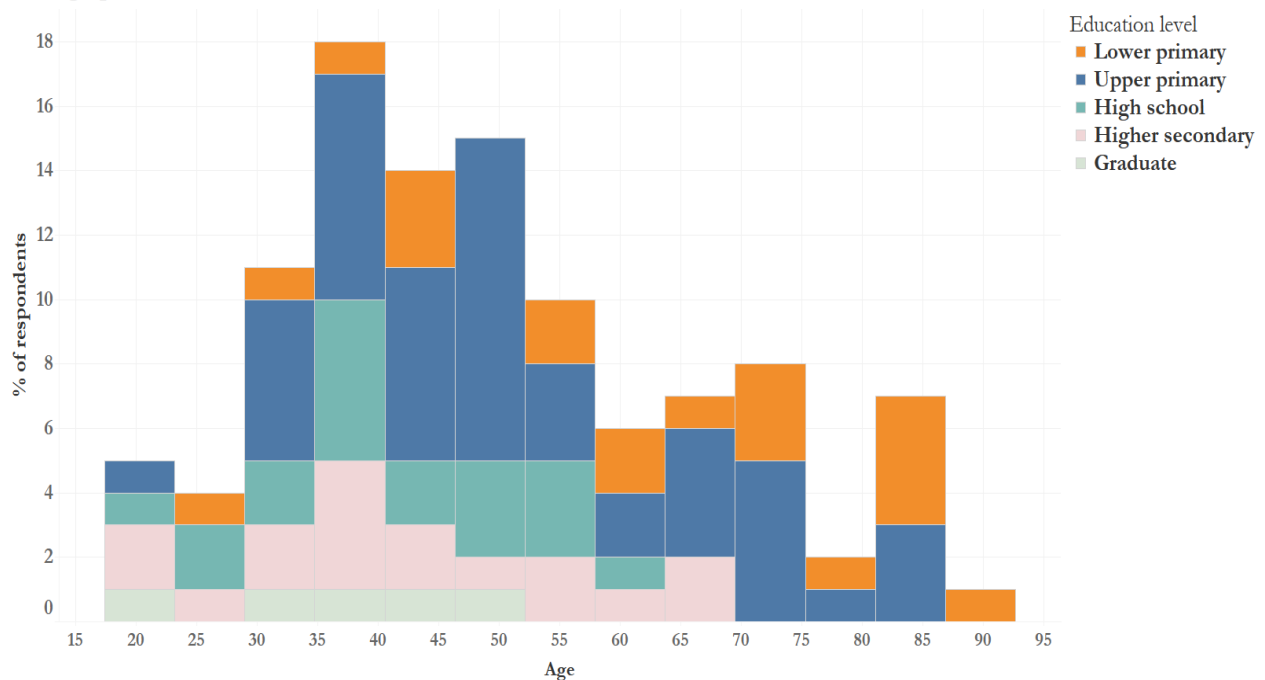
Figure 17 Skill level plotted against age

4.1.1.3. Skill level

The recent literature on human development considers Skill level of stakeholders' as agents which empower them (Heckman & Corbin, 2016). Measuring skills enhances opportunities to promote capability. Present livelihood activities of the stakeholders were classified into four categories based on the ISCO (International standard classification of occupations) (Figure 18).

a. Skill level 1 = Occupations at skill level 1 involved the performance of routine and straightforward physical tasks. (Cleaners, labourers etc.)

b. Skill level 2 = Occupations in the category involves knowledge in reading or operating machinery. (Motor Vehicle Mechanics, automobile drivers, etc.

c. Skill level 3 = Occupations in this category typically involves the performance of complex technical and practical skills. (Shop managers, computer support technicians etc.)

d. Skill level 4 = Occupations require complex problem solving and decision-making skills, like analysis and research. (Engineers, doctors, schoolteachers, medical practitioners)

Mode of skill level is 1 (57%), with a standard deviation of 0.781 and skewness 1.12. Most of the residents are involved in livelihood activities belong to skill level 1 (low skilled jobs like cleaners, etc.) and Skill level 2 (Drivers, mechanics, etc.) (Table 8). This can also be compared with the change in occupation, 84% of the sample population agreed that they were involved in other livelihood activities inside the island, and they recently moved to the new one, and are not skilled enough to get into the job market and make sufficient income. One of the expert Ankita Bhakthkande agreed to the same. When asked to elaborate, they had to change their occupation to different trades (from farming, fishing, saltpan works to daily wages works in the city like sewage worker, cleaner, etc.) in the past few years due to the changes occurred. 36 % of the stakeholders' who changed their livelihood activity, mentioned they had to find new occupation due to "government rules and regulations", and, 45 % mentioned they needed "more income". This is related to the recent trend in stakeholders' leaving agricultural, fishing and salt pan activities on the island and starts working in the city. Stakeholders' were involved in four major activities, salt pan, fishing, sand mining, and agriculture.
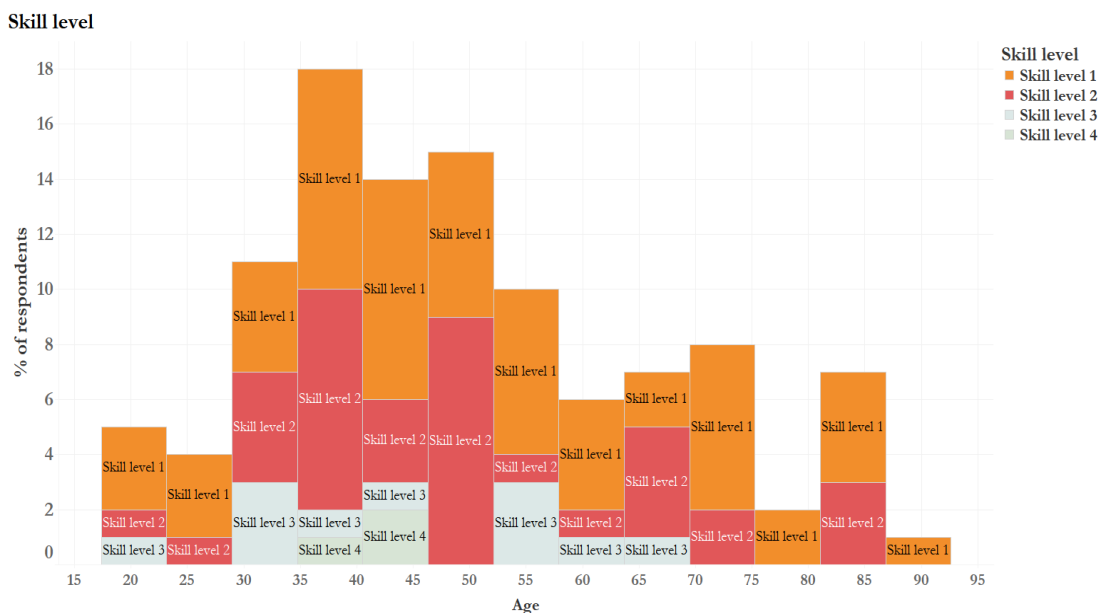
Figure 19 Skill level plotted against age

When compared the skill level with age, a similar trend like dropping out of schools is visible here. In all age groups skill level 1 and skill level 2 is the majority. It is important to note that even in the newer generation, the sample population is involved in livelihood activities of lower skill level.
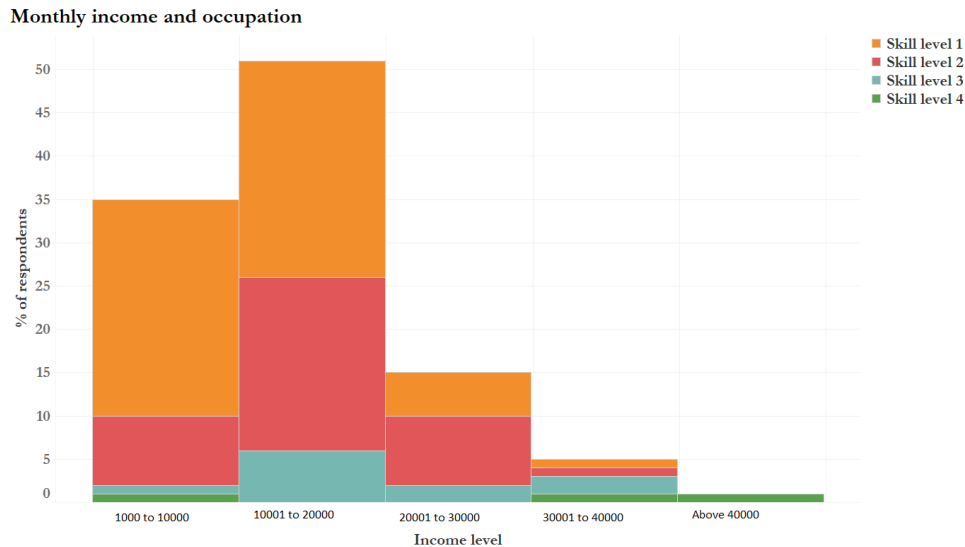
Figure 20: Graph explaining skill level and income level of the sample population

25 % of the total sample population still involved in livelihood activities (saltpan, farming, fishing, agriculture, and sand mining) which are dependent on ecosystem services. Compared to the past, 51 per cent of the sample population was involved in the ecosystem related to livelihood activities (Figure 21Figure 21 Shows involvement of the respondents in ecosystem related livelihood activity in the past. "used to work inside" can be considered as a proxy to such activities, as there are no other opportunities available inside the island. Majority of the sample population is involved in more than one livelihood activities. Change in the government policies (within the last ten-year time) forced many of Panju island residents to change their occupation. Out of them, 36 % of the sample population have mentioned the new rules and regulations as the reason for this change. At the same time, 46 % of the sample population mentioned, they had to change the occupation because agriculture and salt pan and fishing became economically non-viable. In addition to that, 15% changed their occupation because of personal reasons. Three percentage changed the occupation because of the change in ownership issues.
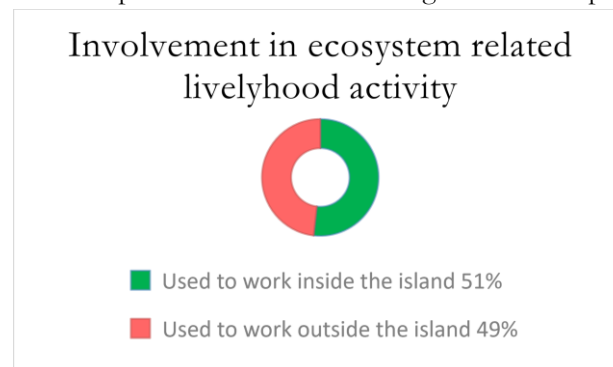
Figure 21 Shows involvement of the respondents in ecosystem related livelihood activity in the past. "used to work inside" can be considered as a proxy to such activities, as there are no other opportunities available inside the island.

4.1.1.4. Availability of water

There are two major ponds inside the island; still, stakeholders still suffer to get enough drinking water. Their major source of fresh water is a pipeline coming from Bhayandar (nearest municipality). On an average resident of the island receives water six times a week (Figure 21), but the standard deviation is 3.2, which means there is a considerable difference in availability and accessibility to freshwater between stakeholders. Looking at the variability in the number of times a family receives water, the following can be concluded. Water coming through the pipeline is not being distributed equally to everyone. A few get water every day, and some families get it once or twice in a week. Stakeholders mentioned "Some weeks water will not come for few days", "The pipelines get damaged frequently." On a normal maintenance day, the stakeholders will not receive water for 2 to 3 days (Text box 2)
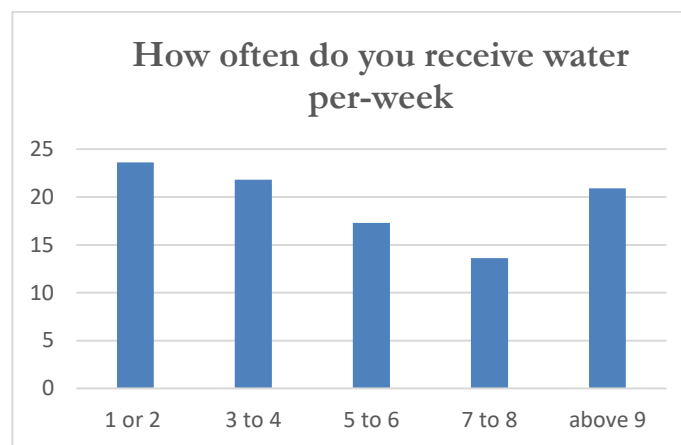
Figure 22 Access to water (frequency)

One issue is despite having a freshwater source inside the island. Stakeholders are completely depended on water coming from outside. This lead to management issues of the existing water bodies.

Stakeholder male 65 years old: Water problem should be solved. Though it has got much better now than earlier times. We get water once in two days most of time. But still it is not enough, and it is not reliable.

Text box 1 Perception water

4.1.2. Subjective conditions of well-being

Subjective conditions of well-being are measured with the help of the following indicators, health good social relations, safety, and freedom of choice and action. Unlike the material aspects of well-being, subjective conditions of well-being are indirectly related to ecosystem services (the relationship and perception are mediated by other factors). To understand this relationship, the analysis was done at a different level. Unlike the previous sections where the analysis is mostly on community-level, an individual-level analysis is conducted to understand what mediates the difference in subjective well-being

conditions. Based on preliminary analysis, the stakeholder's involvement with ES (as a livelihood activity) was chosen to highlight the difference, as it showed a greater degree of variation compared to other factors (like age, gender, income, education, or skill level). So based on the dependency, four classes were created, *self-employed inside the island*, *self-employed outside the island*, *employed for wages inside the island*, *employed for wages outside the island*(Annex 8.7, the classification is based on the inputs provided by the stakeholders in terms of their current and past occupation. As the culture and life of stakeholders are developed around the livelihood activities, these groups define their relationship with ecosystems[26].

4.1.2.1. Access and availability of food

32 % of the sample population mentioned that they do not have proper access to food. What defines proper access and availability here is they do not get enough provisions inside the island., it does not mean hunger or poverty. As the island has seasonal accessibility issues due to weather events, transportation of goods is not always possible. Also, the recent trend in dropping the production of rice and collection of fish, and fruits inside the island could be another reason. This does not mean poverty or hunger. This part explores how self-sufficient the stakeholders were in case of food production in the past. They are gradually stopping agricultural practices due to ownership issues, new regulations, and issues related to transport. Some interesting quotes recorded during the data collection, which explains their concerns about access and availability of food (Text box 2)

These responses explain the difficulties the residents face now due to the changes that happened to agriculture practices.

Stakeholder male 52 years old (farmer): "We were into agriculture in the past! But now we stopped our farming practices. As it became very expensive, to transport goods and due to regulations, we are not allowed to build any supporting infrastructure."

Stakeholder female 30 years old: "We have to take the boat and go to the town to purchase everything, previously we use to produce things, but we do not do that anymore. This causes issues with availability, sometimes when the boat stops working."

Stakeholder male 52 years old (farmer): "We were into agriculture in the past! But now we stopped our farming practices. As it became very expensive, to transport goods and due to regulations, we are not allowed to build any supporting infrastructure."

Stakeholder female 30 years old: "We have to take the boat and go to the town to purchase everything, previously we use to produce things, but we do not do that anymore. This causes issues with availability, sometimes when the boat stops working."

Text box 2 Perception about food

[26] Self-employed or employed inside the island means they are involved in either fishing, saltpan works, or agriculture. Employed or self-employed outside the island means their livelihood does not have any direct relationship with island ecosystems.

4.1.2.2.   Health

Three indicators were considered to understand the health dimension. One, visitation to the doctor; this explains the number of visitations a person had made to the hospital in the past three months. Two, what was the reason behind this visitation, in this way unwanted[27] information about visits due to other personal reasons was removed from the analysis. Three, during the visit, what was the doctor's comment or advice received, this gives an idea about the living environment and lifestyle[28].

57 % of the population visited the doctor at least 1 or 2 times in the last three months, and 30 % of the population visited 3 to 4 times (Figure 22). Respondents were also asked the reason behind visiting the doctor. Viral fever, malaria, typhoid, and elephantiasis is also common in the study area. The doctor advised most of them that water quality may be an issue for your illness.

How often did you visit the doctor in the past 3 months?
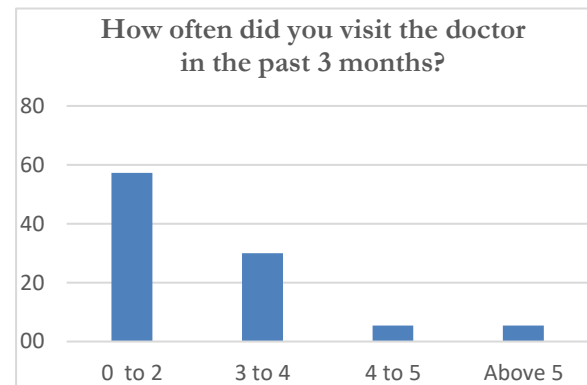
Figure 23 Visitation to doctor

While analysing the common reasons behind visitation to doctors, this study found waterborne diseases are very common in the study area. Like viral fever, common cold, etc., When analysed the doctor's suggestion, and the most common reply was water quality issue, weather-related issues, and nutrient deficiency. Communicable, vector-borne diseases are present in the study area (Figure 24), for example, malaria, dengue, typhoid, and elephantiasis. Quality of living environment and quality of water are the primary reasons behind the occurrences and spread of such diseases according to the doctor's suggestion to the respondents. According to the experts and the stakeholders, seasonal occurrences of these diseases are very common.
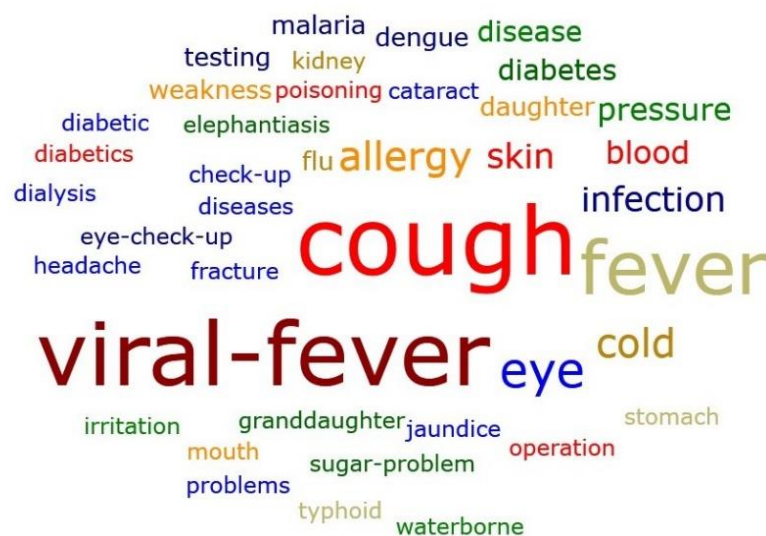
Figure 24 Word cloud the reasons being visitation to doctor

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[27] Some people mentioned that they visited the hospital to meet, relatives, friends etc. such information's was not used for the analysis.

[28] This can reveal information about the quality of living environment. Example issues related to water quality was mentioned many times by the doctor.

An analysis of the doctor's comments highlights two issues, one, issues with water quality, 41% of the sample population mentioned they are not satisfied with the water quality. Two, nutrition deficiency, 39% of the sample population mentioned that they do not have enough access to food. Assumptions on nutrition deficiency can be made by linking the change in occupation from agriculture and fishing to others. Studies on community ecology considered nutrition as a relevant ecosystem service (Declerck, Fanzo, Palm, & Remans, 2011). The residents have mentioned that the fruits, fish they collect etc. was a part of their food system. Abandoning those practices might have created a hidden hunger which cannot be compared the actual hunger. Ecological knowledge has an important role in the complex multi-dimensional nutrition problem.

4.1.2.3. Access, quality, and quantity of freshwater

In general, the sample population agrees that the access, quality and of water received is good (with the median as 4 (agree) and mean 3.29[29]). Perception about access, quality and quantity of water is subjective. Majority of the sample population (60%) agreed that they have enough access to water. In case of quality, 41 % of the sample population mentioned that they disagree with the statement that they receive a good quality of water, the same for quantity (44%), This finding agrees with the section on availability of water (4.1.1.5). These two highlights the issues and uncertainties with fresh water on the island and the need for a local source for freshwater inside the study area.

Perception : Access, Quantity and Quality of water

	Completely disagree	Disagree	Neutral	Agree	Completely agree
Access to water	25	09	06	14	46
Quality	22	19	04	12	44
Quantity	22	20	04	14	40
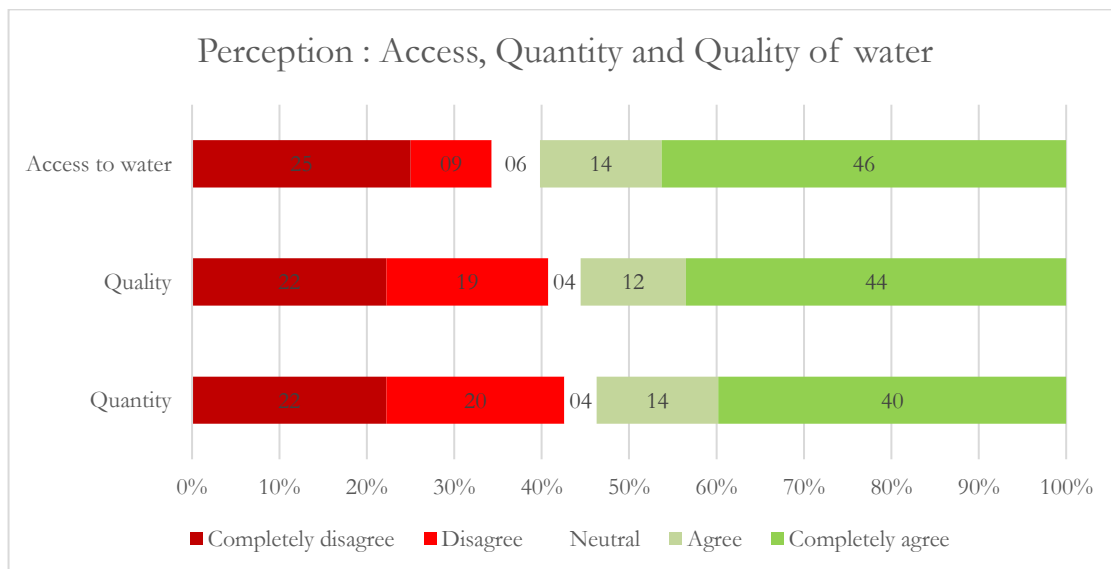
Figure 25 Perception of quantity and quality of water

4.1.2.4. Social relations

Stakeholders, in general, possess a good relationship with their neighbours (Figure 26). This indicates social cohesion (Figure 26). This positively contributes to community interactions, which is very vital. Ecosystem services, notably cultural and provisioning, also contributes to social cohesion (through involvement in same livelihood activities). Overall, the perception about the relationship with others and the willingness to collaborate for a common cause is good. 60 % of the sample population have agreed,

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[29] 1 = Completely disagree, 2 = disagree, 3 = Neutral, 4 = Agree, 5 = Completely agree.

they have good relations with neighbours. 57 % of the total population have agreed that they collaborate with other stakeholders for work and other activities.
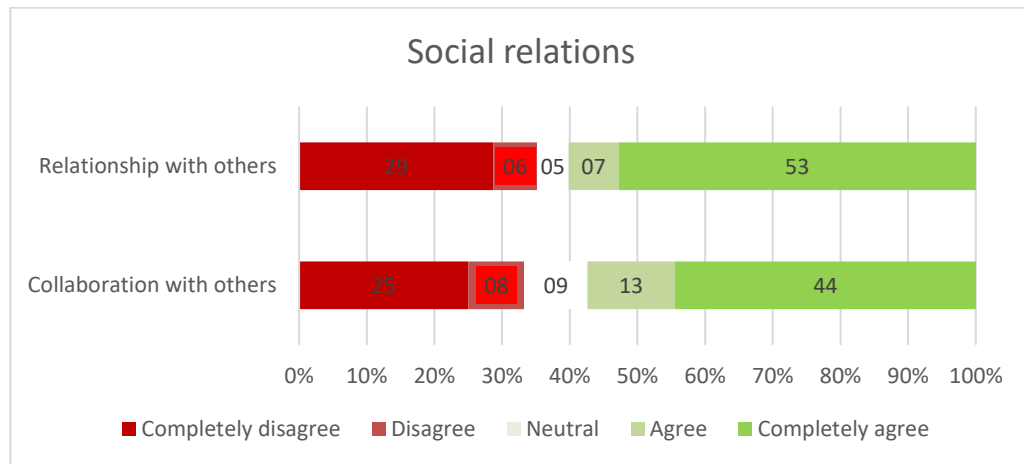
Figure 26 Perception about social cohesion, explained in terms of relationship and collaboration with others (analysis: community level).

Perception about social relationships, collaboration with others, and participation in Gram-Sabha (local body meetings) is different among different stakeholders. An analysis with multiple characteristics of the sample population was conducted to identify which characteristic shows a significant difference. Among them, stakeholder's involvement in ES related livelihood activities (fishing, agriculture, saltpan, sand mining) is one characteristic which showed a major difference (other characteristics tested was age, gender, and education).

Table 8: Hypothesis test (analysis: individual level) (Kruskal- Wallis test).

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	We collaborate with each other - is same across stakeholders' working inside the island and outside the island.	Independent-Samples Kruskal-Wallis Test	0.176	Retain the null hypothesis.
2	We have good relationships with others - is same across stakeholders' working inside the island and outside the island.	Independent-Samples Kruskal-Wallis Test	0.097	Retain the null hypothesis.
3	We participate in Gram-Sabha - is same across stakeholders' working inside the island and outside the island.	Independent-Samples Kruskal-Wallis Test	0.030	Reject the null hypothesis.
Asymptotic significances are displayed. The significance level is .050.				

The analysis found a clear difference in the perception among stakeholders' who are involved in livelihood activities inside the island *(self-employed inside the island)* compared to the stakeholders who work outside the island (*employed or self-employed outside the island*) (based on the data collected, four stakeholder groups were identified, one, *stakeholders who are self-employed inside the island* (farmers, salt-pan workers, sand mining or fishing), two, *stakeholders who are self-employed outside the island*, three, *stakeholders who are employed inside the island*, four *stakeholders who are employed outside the island*). The difference in perception between stakeholders involved in livelihood activities inside the island and outside the island was analysed with Kruskal-Wallis test[30], in terms of the relationship between stakeholders no significant differences were found (sig = 0.097,) (Table 8). But, when explored in detail (Annexe: 8.7 Table 14), stakeholders who are self-employed inside the island showed larger mean and agreed that they have a good social relationship with others. The mean was 5 (in a likert scale from 1 to 5, 1 = completely disagree, 5 = completely agree), compared to the stakeholders who are employed outside (mean = 3.5). In case of collaboration with others (sig = 0.176), there is no significant difference in perception but similar to the previous observations stakeholders who are employed inside possessed higher mean value (mean = 4, compared to the other groups). But in terms of participation in Gram-Sabha, all groups of people mentioned higher levels of participation (agreed to the statement that they participate in Gram-Sabha). Even though the expected result was stakeholders who are involved in livelihood activities inside the island participate in Gram-Sabha more compared to other groups, the reason behind could be one of the following. The stakeholders were involved in livelihood activity inside the island or because their culture is evolved depending on the livelihoods, and they still experience that connection.

This observation is important because livelihood activities inside the island are related to provisioning ecosystem services. So, the difference in the perception mentioned above highlights how different ES contributes to this dimension. The dependency on ES for livelihood activities influences stakeholder's social cohesion, relationship with other and participation.

4.1.2.5. Safety

The safety dimension includes secure access to natural and other resources, the safety of person and possessions, and living in a predictable and controllable environment with safety from natural and human-made disasters. Following are the indicators used to define this well-being dimension. One, safety in terms of natural disasters (flood), two, perception about future safety from natural disasters, three, safety in terms of livelihood. The third one was not a direct measurement; assumptions were made based qualitative analysis of stakeholder's perception about their livelihoods and concerns. In general, the sample population agrees that Panju is a safe place to live (mean 3.75) Also, they are not in threat of a natural disaster (future safety) (Figure 27). However, experts suggested that it is not true; they live in an area which is exposed to natural disasters, especially flood. Experts also mentioned that there had been many small- and large-scale incidents of flood occurred in the past. The perception about safety was high with stakeholders who are involved in livelihood activities inside the island (mean = 4.75, standard deviation = 0.5) and stakeholders who work outside had a lower perception about safety inside the island (mean = 3.31, standard deviation = 1.9) (Annex 8.7). A similar trend was observed in perception about future safety, sample population who work inside the island did not agree that they feel a natural disaster will occur in future (mean = 2, standard deviation = 0.86) and sample population work outside agreed to the opposite (mean = 3.83, standard deviation = 1.29) (Annex 8.7).

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[30] Nonparametric test used to compare three or more groups on an ordinal dependent variable.
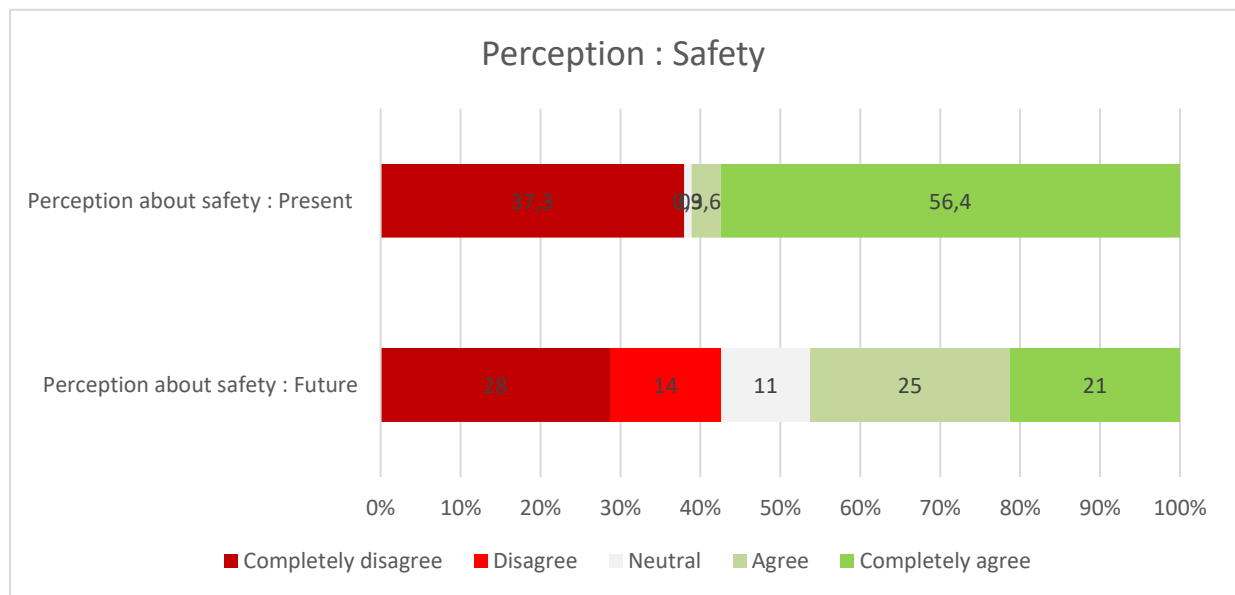
Figure 27 Perception: safety (flood) (community level)

An analysis of what contributes to the perception of safety from the flood was conducted, the assumption was the presence of mangroves, and the recognition of regulating ES value influences this perception. But, the majority of the sample population recognizes the flood control and prevention function of mangroves. So, in that way, any statistical analysis did not provide reliable results.

Safety with respect to the livelihoods is explored with stakeholders' general concerns. Text box 4 contains a few interesting statements, the stakeholders mentioned regarding livelihood security. The safety with respect to the availability of livelihood opportunity is also an important aspect of wellbeing. Most of the sample population mentioned they are not happy and feel safe because of the change happened to the provisioning ES (agriculture, saltpans, and sand mining). These changes not just affected their income, but also affected their perception of safety with respect to resources available for a better life in the study are

4.1.2.6. Sense of place

The sense of place or the perception of an individual about belonging to a community is gauged with two indicators. One, their willingness to move out (1= Neutral, 2 = Yes, 3 = No) (Figure 28), two, the motivation behind it

Stakeholder (farmer) : Since agriculture also happens on the island, we get certain crops at a lower rate. But if we were to get it from outside the island all the time, the transportation cost would increase.

Stakeholder (farmer) : Agriculture is important to our family as it gets the extra income.

Stakeholder (cleaner) : Sand mining was the main source of living as it was banned it will affect the living conditions

Stakeholder : Affecting my social economy and standard of living my family as the complete economy was dependant

Stakeholder : It was the part of my day to day life as because of these restrictions disturbed badly.as now we need to survive in bad conditions as the source of income stopped.and on the island their is no other source of income.

Text box 3 Safety (livelihood)

(why or why not). The mode response was 2, 83 % of the stakeholders responded that they do not want to move out of the island. Ten percentage mentioned that if given a chance, they will move out. The stakeholders who wish to stay inside the island mentioned that they were born and brought up here on the island, their livelihood activities (primary or secondary) are based on the resources available on the island[31].
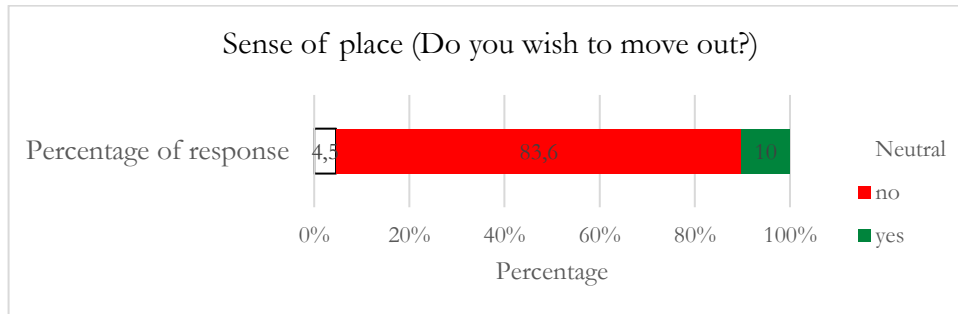
Figure 28 Sense of place and belonging (community level)

The stakeholders who wish to move out of the island and their family members were not involved in any activities inside the island. Even within the stakeholders who wish to moveout strong social cohesion was found. The major motivation behind this thought (to move out of the island) is accessibility to the workplace, lack of facilities available and for better wages. However, for everyone, one fact is common; they were involved in an ecosystem related to livelihood activity in the past, their culture and relationships are developed around it.

4.1.2.7.   Freedom of choice and action

This dimension explores how democratic, policy-making processes are in the study area. Freedom of choice (including having control over what happens and being able to achieve what a person values doing or being). The freedom of choice and action can be defined by looking at the participatory nature of the decision-making process. Table 8 explains the participation of sample population in the local body meetings (Gram-Sabha), but that does not explain whether the respondents are allowed to raise their concerns, or the village managers take their concerns while making decisions. So, two more indicators were used to understand the actual participation. One, are they allowed to express their concerns in local body meetings (freedom of speech)? Two, does the village managers considers their concerns in decision making? (Opportunities in -Decision making).

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[31] Even though major income source of most of the sample population is from outside, many of them are still involved in fishing, saltpan works, and agriculture as their secondary source of income.
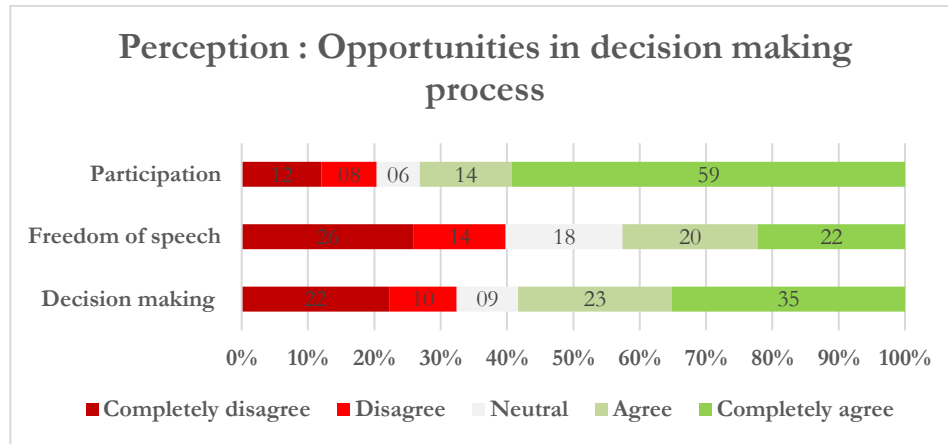
Figure 29 freedom of choice and action

Freedom of speech stands as a proxy to the respondent's ability to raise concerns in the local decision-making process. This was measured on a 5-point scale[32] (even though most of the residents participate in the local body meeting (Gram-Sabha), not everyone is free to raise their concerns (Figure 28). Only 44 % of the sample population agreed that they could raise their concerns in local body meetings. The rest do not agree with this. An exploratory analysis was done to understand how this perception varies between different groups of stakeholders. The same four classes were used alike the previous sections (stakeholders who are self-employed inside the island, employed inside the island, employed outside the island, and self-employed outside the island). Similar to the differences mentioned in the previous section, sample population who are self-employed inside the island (involved in fishing, agriculture etc.) perceived higher involvement in the decision-making process (mean = 3.75 and median= 4.50, standard deviation= 1.893) (Annex 8.7). Compared to stakeholders who are employed and self-employed outside the island (employed outside - mean = 2.78 and median= 3, standard deviation= 1.73). However, stakeholders who are self-employed outside the island also perceived higher involvement (mean = 3.44 and median= 4, standard deviation= 1.4).

Similar results obtained in the involvement in the decision-making process. Here 58 per cent of the stakeholders perceive that their opinions are valued by the village managers (That they are involved in the local decision-making process). Stakeholders who work outside perceive less involvement in the local decision-making process, compared to the stakeholders who are still involved in livelihood activities inside the island.

4.2. Ecosystem services: values, benefits, and changes

During the interview process information regarding different ecosystem services available inside the study area was collected. This information, along with the output of participatory GIS, is used to identify and prioritize ES services inside the island. Based on the description provided, I classified them (based on MEA framework and the preliminary list prepared (Table 4)) into three major classes (provisioning, regulating and cultural). The questions were designed in a way to gather information about the most

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[32] This was recorded in a 5-point scale (1= completely disagree, 2 = disagree, 3 = neural, 4 = agree, 5 completely agree), to a question "I have the opportunity to participate or express my opinions".

important ecosystem services, which has a direct relation to the well-being dimensions. Majority of the respondents mentioned about provisioning, cultural and regulating ES (regulating ES like soil fertility and flood prevision by agricultural areas and mangroves).

An analysis of the change in perception was done to understand are there any differences in perception among different groups of stakeholders in sample population (age, gender, or livelihood activity) in both spatial and non-spatial context. I could not find any major difference in the spatial context, but there was a significant difference in the non-spatial context (with respect to livelihood activities). The reason is the fact that most of the stakeholders on the island was involved in livelihood activities within the island and made use of the ecosystem services available inside the island. This dependency has created awareness and knowledge of different ecosystem services. Based on age and involvement in livelihood activities, the respondents highlighted different locations in the study area.

List of major provisioning ecosystems was prepared by compiling inputs from expert interviews (Table 13). Out of that, the availability of fish, agriculture, saltpans, water, and timber has the highest priority and possess a direct relationship with both objective and subjective conditions of life. Apart from the provisioning, the sample population recognizes regulating ES like flood prevention, clean air and cultural ES like tourism, and spiritual values associated with landscapes.
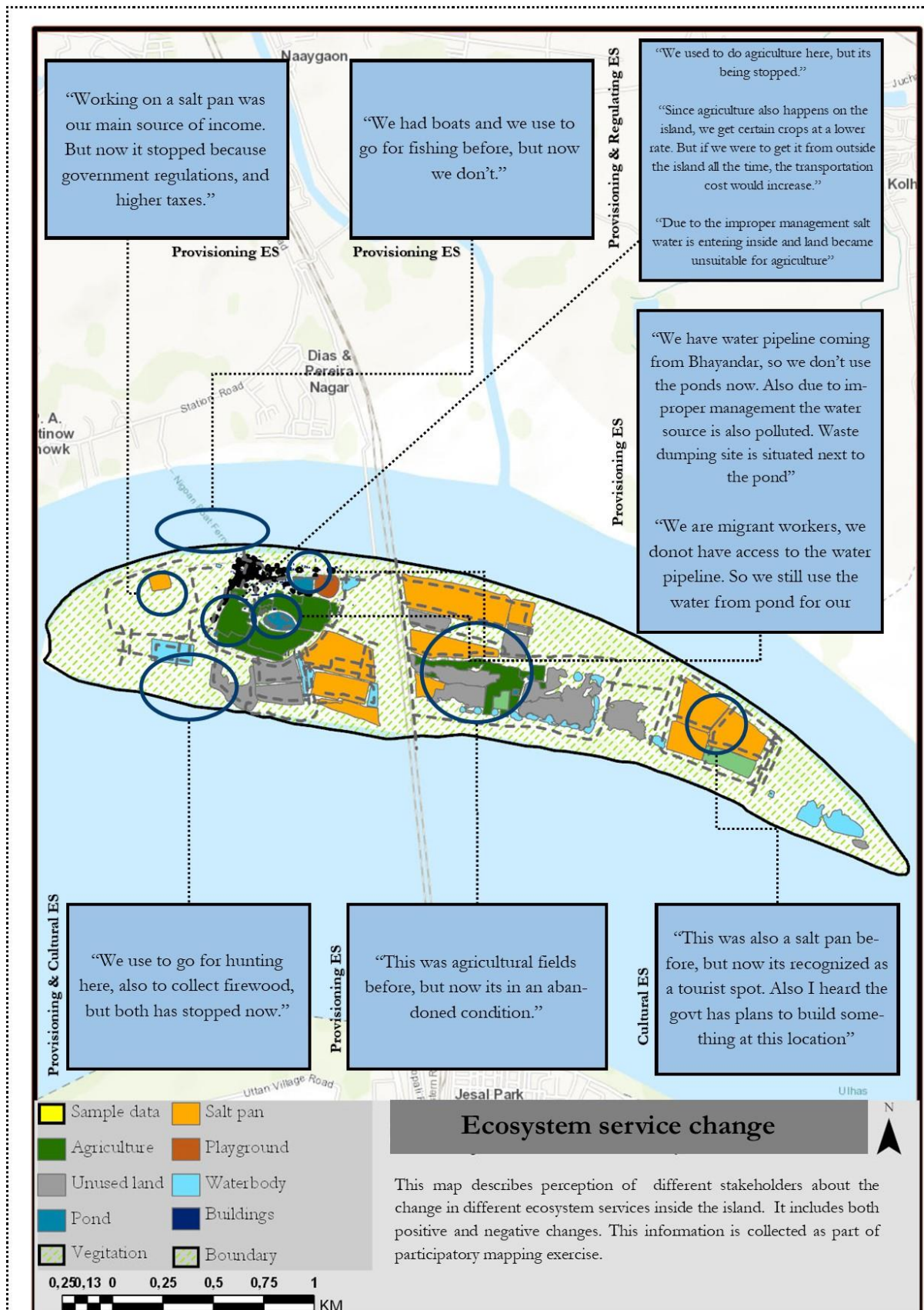
Figure 30 Ecosystem service changes

Figure 29 is a visualization of stakeholder's perception of change in ES in different parts of the island. All the responses mapped describes how changes in ES due to different drivers of change affected the life of stakeholders. Especially the changes happened to provisioning ES (which supports the livelihood activities of the stakeholders). This information can be used for management prioritization by looking at their present and past use and the stakeholder's perceptions.
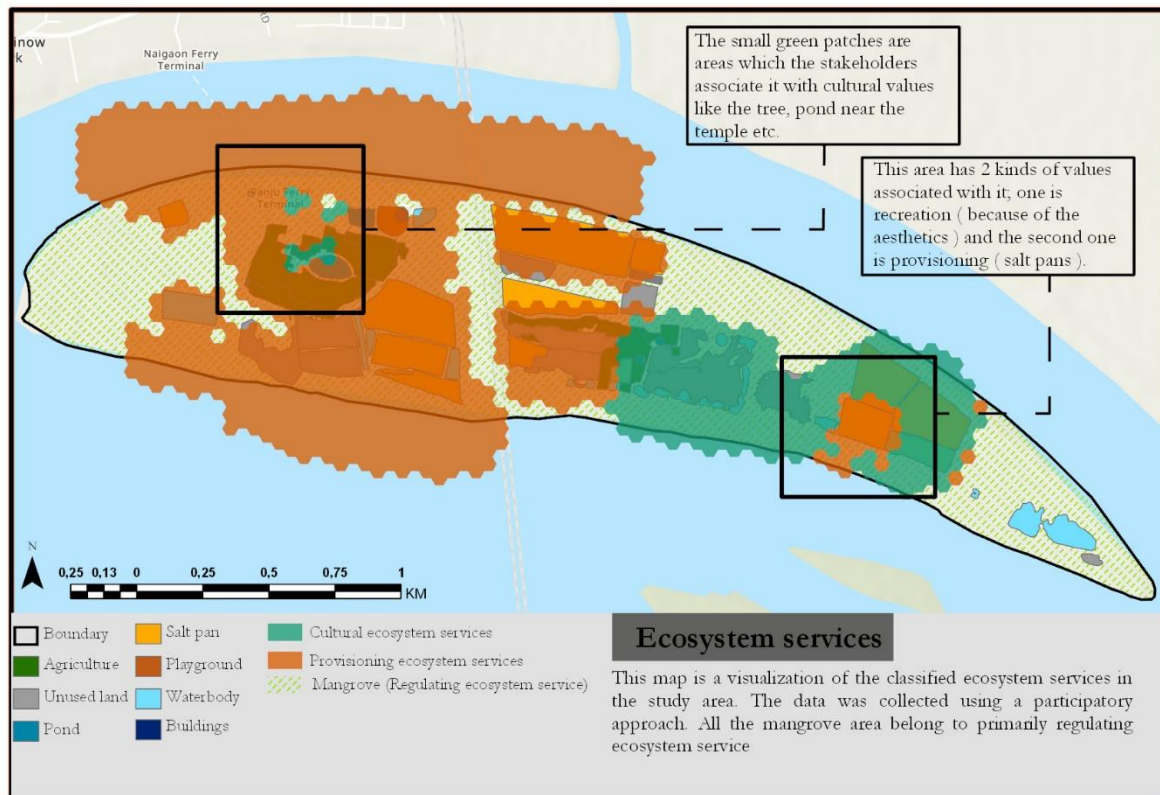
Figure 31 Ecosystem service categories. The classification of stakeholder's responses was done based on MEA 2005

Following sections describes different ES benefits from different ES provisioning areas. Most of the Ecosystems has more than one value associated with it. For example, saltpans are both provisioning and regulating ES (Figure 30).

4.2.1.   Saltpans

Brackish water aids in the development of saltpans, it is considered as the traditional occupation of the stakeholders. Salt pans are not only a provisioning ES but also a regulating ES. 23% of the sample population mentioned that they were involved in salt pan works. The salt pan is highlighted as one of the major ES provisions by the stakeholders and the newspaper reports, which describes Panju island (Iyer, 2017). The stakeholders mentioned saltpans and its importance in many instances during the interview process. Compared to fishing and agriculture where stakeholders had to change occupation because they needed more income (majority not all), and they realized it is not economically non-viable, the case of the salt pan is different. Majority of the stakeholders who were involved in a salt pan works mentioned "the change in new rules and regulations" as the reason in the form of increased taxes. Agreeing to this

statement Ankita Bhakthkande, a reporter from times of India mentioned that "salt pans taken over by private companies".

In India central government claims ownership of all saltpans, the same applies to salt pans of Panju also. The Zilla Parishad (district councils) alleged that stakeholders should return the land to the government and said that they were only on a lease (Bharucha, 2016; Bhatkhande, 2014), and stakeholders cannot own the land. Due to the high assignment fee, and the laws and regulations associated with it, the stakeholders of Panju had to leave this trade.

Figure 32 Salt pans in harvest time. Source "The better India":
https://www.thebetterindia.com/99078/agri-panju-island-vasai-creek/

The recent reports on declaring the island as a tourist village and associated development planned, in locations where salt pans are present, not only going to affect the livelihood but also exposes the island to more natural disasters. Salt pans are an important part of the island's ecology. That salt pans act as a defensive mechanism and prevents coastal erosion. They are ultimately giving protection from flooding (Loon-Steensma, 2014).

4.2.2.   The creek

Out of the stakeholders whose primary or secondary livelihood activity is depended on provisioning ecosystems services, 14% of the sample population is depended on fishing. Many of them had to change the occupation because fishing became economically non-viable. All the stakeholders who were involved in fishing mentioned that they had to change the occupation because they needed more income. I also observed the change in the value assigned to fishing as an important ES in the study area. Grey literature collected, discussions with the village leader, and interview with the experts suggested that fishing is a part of the culture and an important livelihood activity in the study area. However, the information obtained from the sample population tells a different story. Right now, only a small share of the sample population is depended on fishing. Most of the boats docked around the village is in non-recoverable condition (Figure 33).

Sandeep Menon, an expert involved in research on ecological systems of the island mentioned that fishing is not only related to stakeholders livelihood but also a part of local food systems: "Fish, clams, prawns, crabs etc. are commonly consumed here-all caught from the estuary".

Figure 33 Boats docked at the entrance of the island (Photo credits: Self)

4.2.3. Agriculture and Timber

Agriculture can be considered as the third most important livelihood activity inside the island. Like the issues mentioned in the previous sections, economic viability and ownership related issues are affecting the agricultural land. In addition to that, lack of improper management let seawater enter the agricultural land, and the land is losing its fertile characteristics. Being in the CRZ 1-A[33] (Annexe: CRZ map and regulations) category of the coastal regulation zone also prevents the farmers from building supporting infrastructure. Similar issues are applicable to timber. Also, new rules and regulations do not allow the stakeholders to collect timber for domestic use also.

4.2.4. Sand-mining

Sand mining is the fourth major occupation among stakeholders. Due to the CRZ regulation, it is now an illegitimate business. However, still, many stakeholders are involved in the sand mining business. Many residents refused to talk about it, but they agreed that they were involved in sand mining business in the past. Ajay Khamble an expert in geomorphology and a professor at the Bhavan's college Mumbai, mentioned: "*Sand dredging and trading in construction material is a lucrative option for livelihood for the people of Panju*". Like mentioned in the description of the study area, the island is geographically located at the mouth of Vasai creek. The creek discharge brings a large amount of sand every year; initiatives can be made to mine them sustainably. Even though as per the responses received from the sample population "The sand mining" business is only the fourth major livelihood activity, two of the experts do not agree with it. As

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[33] CRZ 1 A refers to ecologically sensitive area and considered as essential maintaining ecosystem of the coast.

per their studies in the past, sand mining is the major livelihood activity; they consider salt pan work as the second one.

4.2.5.   Mangroves

The island has its mangrove cover around the edges like a shield. It is considered as both provisioning and regulating ES. During the interview process, all the stakeholders (100%) who perceived a higher level of safety inside the island from flood mentioned about the ability of mangroves in flood prevention. In general, the villagers' value the mangrove as a shield that they have along the island (Text box 5). 26% of the sample population mentioned that they visit the mangrove forest daily for firewood collection. In addition to that, 68 % of the sample population mentioned that they visit mangrove occasionally, and the purpose of the visit is either firewood collection or fishing.

The mangroves cover a larger portion of the island, along with other vegetation it provides clean air and a healthy environment to the residents. Many of the residents mentioned that they are aware[34] of it and are willing to work for the betterment of the village.

Some of the villagers also mentioned that due to rules they are not allowed cut the mangroves, and now the mangroves are growing at higher rate consuming more space and making some places inside the island inaccessible and unusable.

Stakeholder:*"Mangroove is a protection layer and the part of large ecosystem of many aquatic animals"*

Stakeholder: *"Pollution should not increase in the island like the way it is increasing in the other parts of the city. Panju is the only place in Mumbai where the air is so fresh and clean. We need to take care of it and maintain it the same way. Thanks to the green evironment here."*

Sandeep Menon (Expert) :- *"the people already consider the mangrove edges as a natural shield but the governmental policiles of making a 'sea wall' to protect the island from erosion etc will lead to the mangroves being erased from the edges of the island."*

Text box 4 Perception - mangroves

4.2.6.   Freshwater ponds

The island has two freshwater ponds, but both are not in good condition now. The stakeholders mentioned that they regularly used it in the past before the government brought the pipeline connection to the island. In the first place, the residents are thankful as the pipeline made their life much easier. During the discussions with the previous village leader, he mentioned how difficult it was in the initial

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[34] 77 % of the sample population agreed that the quality and quantity of mangroves available in the island increased. Also, 62 percent of the sample population mentioned it supports the biodiversity (in terms of protecting the flora and fauna.

days to bring drinking water to the island. Nevertheless, this affected the freshwater sources inside the island. As the dependency is reduced, stakeholders started dumping household wastes near the waterbody; thereby, it became non-usable. A series of incidents led to this issue. First one is the anthropogenic asset (pipeline), this led to stakeholders neglect the water source, a garbage disposal area was placed near this water body, and later stakeholders started using for other purposes like laundry etc.

The reason why this water source is still relevant to the residents is the issues associated with water pipeline. Stakeholders mentioned that they cannot rely on pipeline always, it breaks on a regular basis. A female resident explained that once the water did not come for a few days, and they had to use the unhygienic water from the pond (Text box 6). Apart from that what I consider as the major issue is, the pipeline comes through the abandoned railway track which is going to be demolished soon. The western railway issued statements on October 2018 mentioning they are going to demolish the track soon (The Voice Of Citizens (@tVoiceOfCitizen) / Twitter.) (also public notice was issued by the western railway Annex 8.10). All these issues point to one direction. The freshwater source is important to the stakeholders, even though it is not used now

> **Stakeholder :-** *"As we have water on our doorsteps we don't want to go and collect water from pond, its extra work"*
>
> **Stakeholder :-** *"The community neglected this source, and now its polluted. I think the sarpach and the government shoud take care of this, they need to bring in better management practices so that the water stays clean and fresh "*
>
> **Stakeholder :-** *"The migrant workers still useses this water as they are not allowed/ donot have access to the pipeline water"*

Text box 5 Perception - water sources inside the island

4.3.   Ecosystem service hotspots and difference in perception

The stakeholders based on their knowledge, and livelihood activities, perceive and value ecosystem provisioning areas differently in the study area. Figure 34 shows the hotspots of ecosystem services. The hotspots were identified based on the number of responses received from the stakeholders during the participatory GIS exercise. The hotspots are an aggregate of all three types of ecosystem services (provisioning, cultural and regulating) considered for this study. The information can be used ins land use planning process. This information highlights important areas in the island, which are crucial for the wellbeing of the stakeholders. The hotspots identified is mainly on top of (land use) salt pans, agriculture, and fishing areas.
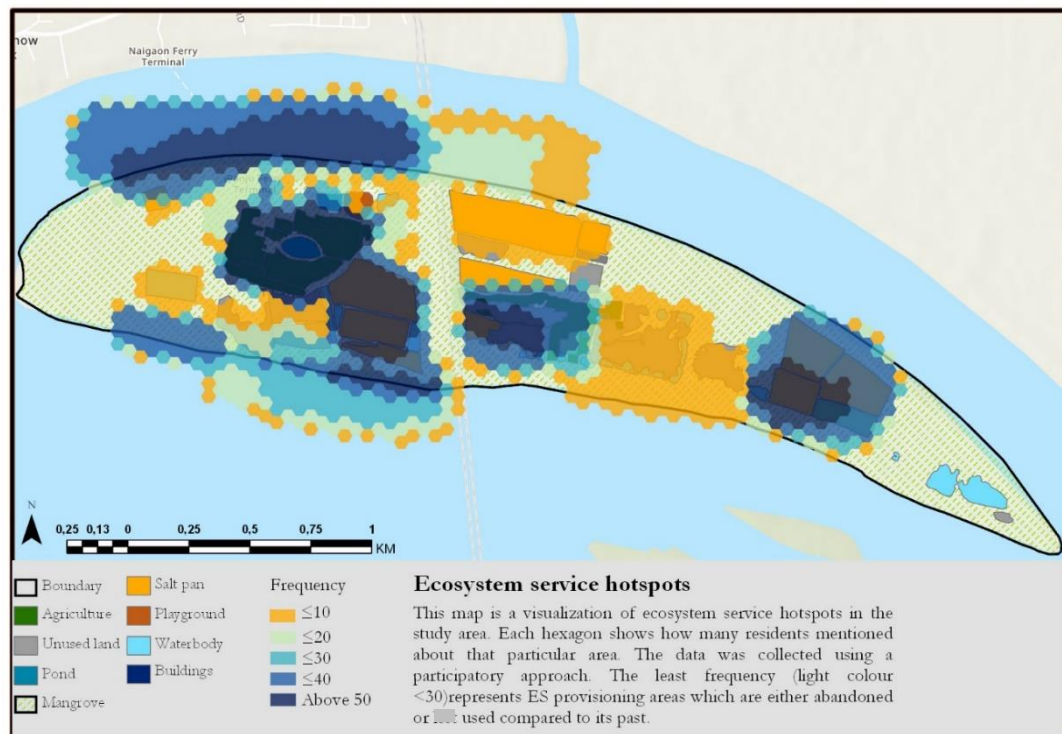
Figure 34 Map showing ecosystem service hotspots. The hotspots were identified based on number of responses received from the sample population

I purposefully removed mangroves from the visualization (classification) to highlight the other ecosystems of importance. Mangroves are spatially distributed throughout the island (Check Figure 34), and the majority of the sample population is aware of its regulating and provisioning ES benefits. Thanks to the local government and authorities for conducting awareness programs which made the stakeholders realize the benefits.

The study also found a difference in perception among stakeholders from different age groups. Comparatively, the young population (15 to 25) mentioned more about the cultural and regulating ecosystem services when the old (above 55) population mentioned about the provisioning ecosystem service. At the same time, experts concluded by mentioning the importance of policy instruments which protects these ecosystems at the same time providing better living conditions for the stakeholders. These findings on the difference in perception between different groups of stakeholders agree with research published on regional environmental change (Walz et al., 2019)

One more interesting finding is the conflict between interests in land use and development plans. Discussions with the village leader and few of the residents revealed that there are plans to build buildings to accommodate tourists on the south-east part (Figure 34: The hotspot area in the east side; Stakeholders explanation can be found here Figure 29) of the island where the salt pan is situated. But the residents of the island associate it to provisioning service as salt pans are important for their survival (Figure 33)): Shows a small patch (highlighted in the box in Figure 30) where 2 types of values are highlighted by the stakeholders.

4.4. The interlinks between ecosystem services and human well-being.

Awareness, practices, related to natural resources, skill and other direct and indirect relationship with natural systems indicate stakeholders' capabilities. For example, values assigned to the mangroves by the stakeholders created awareness and help protect the natural resources. Here the capabilities of human beings to achieve "functioning" (achieved well-being), and, is considered as a proxy to wellbeing (Sangha, Le Brocque, Costanza, & Cadet-James, 2015). According to Amartya Sen's capability approach (Sen, 1985; Sugden & Sen, 1986), the provision of resources (the benefits received from nature: ES) improves stakeholders capabilities thereby it helps them to achieve "functioning". From the study area perspective, the presence of different ecosystems enabled different capabilities (especially income, social cohesion, freedom of speech) and helped them to achieve functioning (it translated into different wellbeing outcomes). However, the current situation in the form of anthropogenic assets, policy changes is affecting the ES, which has impacted their "functioning" at a larger extent.

4.4.1. Synergies and trade-offs

The study found many bivariate relationships between different ecosystem services (Figure 35). There were incidents where ecosystem management practices of once ES lead to another indirect benefit; for example, saltpans do not support the livelihood but also acts a regulating ES. The relationships identified were positive and negative in nature. For example, government rules and regulations which prevents the residents from extracting timber from the mangrove forest directly contributed to the quality and quantity of mangroves in the study area. Also, it influenced perception about safety (flood related) to an extent.
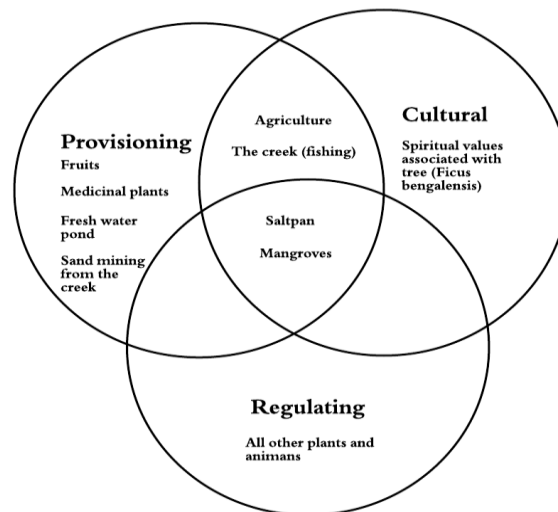
The study found nine major ES[35] valued by the stakeholders and the experts. Presence and continues supply of these is essential for the wellbeing of the residents of the island. In addition to that changes

Figure 35 Major ecosystem services identified at the study area. Each circle represents type of ecosystem service (provisioning, regulating and cultural) Overlapping area indicates the same the same ecosystem provides more than 1 type of service.

happened to two of them (agriculture, saltpans) negatively affected their wellbeing. Proper management and policy instruments can create a positive impact on these ES provisioning areas and ensure the well-being of the stakeholders. Salt pans are the most important one among them. It supports not only the livelihoods of the stakeholders but also has the efficiency in regulating floods. In addition to that, salt pans also have cultural values associated with it. The stakeholders were involved in saltpan works from the last century (for over 90 years); their life and culture are evolved around it. It contributes to their sense of belonging to the place and social cohesion. Mangroves, the ecosystem, which is part of the identity of the village, provides three kinds of services to the island. One is provisioning (firewood, fish), the second one

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[35] Salt pan, Agriculture, Fishing, Mangroves, Fresh water, Fruits, medicinal plants, Spiritual values, and other vegetation.

is regulating ecosystem service (flood control), and the third one is cultural values (tourism, sense of place).

Like the saltpan, the stakeholders possess a strong connection to agriculture. Due to the current issues faced by the agri-community in the form of economic viability and rules and regulation, many stakeholders had to stop the farming practices and seek daily wages jobs outside. Due to special characteristics of the island, commuting in and out of the island is not easy, especially in monsoon season. This leads to seasonal poverty. The case of fishing activities in the creek is similar, fishing is both a providing ES and cultural ES, as it is one of the three major livelihood activities, and it's their traditional occupation.

Even though it is not very evident, the residents of the island were involved in hunting small animals and collecting fruits and medicinal plants in the south-west end of the island. Only a few (2% of the sample population) mentioned this. One of the experts (Sandeep Menon) mentioned about spiritual values associated with a tree, and such values help the protection of the species.

4.5.   Overview

This section is an overview of the results section. All the relevant information which is used in the discussion and to arrive at the conclusions is included in this section.

Overall, the sample population recognizes more than one value (98%) (among provisioning ES, cultural ES and regulating ES) provided by the ecosystems in the island. The sample population mentioned that they need to bring back, agriculture, salt pan and sand mining practices in large-scale for a better life on the island (wellbeing). The experts also agree with the same, one of the experts, Ankita Bhakthkande, mentioned that the stakeholders are not skilled enough to get into a good occupation outside the island. Those who work outside mentioned that they earn less (10000 – 20000 Indian rupees or 120 to 220 euros a month), and they must spend almost 10 to 20 percentage of the same amount in transport. This suggests opportunities inside the island is important for the wellbeing of the stakeholders. It is possible through the sustainable provision of ecosystem services inside the island.

The perception of values and issues associated with different ecosystem provisioning areas is given in Table 9. The values and issues were classified into three classes. One is the abundant values; the stakeholders of the value consider as very important or the values the stakeholders mentioned repeatedly. Two is the values which are less valued (rare values), identified based on fewer mentioning's. Three includes the threats, what are the threats which the experts or the stakeholders feel like affecting the ecosystem provisioning area

Table 9 The table shows the values mentioned by the stakeholders and the experts. Abundant values are the one which is direct and perceived by the stakeholders. Rare values are the one which is not visible or not perceived by everyone. Threats are the drivers of change which affects the provisioning area or ecosystem and influences both abundant and rare values.

ES provisioning area	Abundant values	Rare values	Threats
Salt pans	• Provides livelihood • Sense of place and belonging • Supports the local economy	• Flood prevention	• Government rules prevent the residents from owning the land • Increased taxes • Opening of salt pans for new development
Agricultural land	• Provides livelihood • Supports the local economy	• Sense of place and belonging. • Ensures local food production	• Due to the zoning regulations, the residents are not allowed to sell the land or construct new infrastructure required for efficient farming
The creek (Fishing)	• Provides livelihood	• Importance in the local food system and nutrition	• Lack of external support for maintenance.
The creek (Sand mining)		• Provides livelihood, it is a rare value as it not a legitimate activity	• CRZ rules prevent sand mining. • Unsustainable and large-scale sand mining may lead to ecological problems.
Mangrove	• Flood prevention • Timber • The role of mangroves in maintaining marine fish quantity (Anneboina & Kavi Kumar, 2017)	• Medicinal plants	
Freshwater pond		• Provision of freshwater • Provision of water for agriculture	• After the implementation of the freshwater pipeline from "Bhayandar", these ponds are not being managed properly.

The study identified five ecosystems of importance which has a direct and indirect relationship with different wellbeing indicators. Saltpan, agriculture, and the creek are the top 3 among the others with a strong relationship with material and non-material wellbeing indicators (Figure 36). The figure also shows what the important drivers of change which affected the provisioning of different ecosystem services are. This diagram helps to decide where to focus while designing a policy instrument or while planning an intervention.

The blue coloured lines represent strong relationships; this was decided based on the information collected from the experts and the residents (which is given in Table 9) of the island. Due to the rural nature of the study area, their wellbeing is primarily based on their livelihoods. The experts and the stakeholders agreed to the same, and a stable income source will help them to achieve a better quality of life.
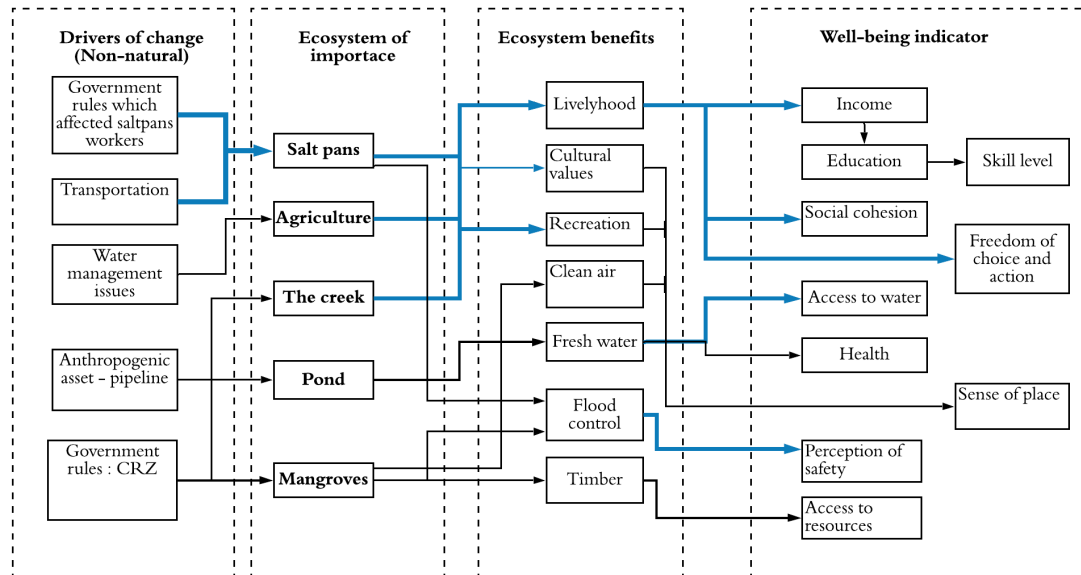
Figure 36 This is a comprehensive overview of all the findings from the previous sections. The diagram explains how different ecosystems if importance provides ecosystem benefits and how it influences different well-being indicators. In addition to that the diagram also shows different drivers of change affecting the ecosystem services of importance. Bold lines represent strong relationships.

5.   DISCUSSIONS

This section includes a detailed interpretation of the results and addresses the research questions and objectives. This section is focussed on drawing conclusions about how ES can contribute to the well-being of the local community through integrated policy responses and the challenges associated with it. Furthermore, this section also describes how national-level policies impacted local well-being.

5.1.   Discussion on key findings

The well-being of stakeholders, in general, retain various levels of dependency to multiple ecosystems of the study area. Dependency on ecosystem does not mean, the well-being of the stakeholders is completely dependent on ecosystem services provided by the local ecosystem. Due to the recent changes in policies and ecosystem service provision, stakeholders are increasingly getting detached from the local ecosystems. The study also identified two major interrelated factors which had a major influence on the dependency and perception about different ecosystems. They are livelihood activity and safety. They are directly related to all other dimensions of well-being. Due to the rural poor nature of the island situated in a vulnerable geographical location, this finding can be considered as valid.

The four trades which the residents of the island (livelihood activities: agriculture, saltpans works, fishing, and sand mining) were involved in, predominantly shaped their culture and society. Their skills are also based on these trades. The reason why the majority of the stakeholders still belong to skill level 1 in the skill classification scheme (OECD & The World Bank, 2013) is because of the same reason. The results of this part agree with the response from one of the expert Ankita bhakthkande "*All three major trades have been stolen away from the people of the island, sand mining is illegal, salt pans taken over by private companies and bad weather and small area not supporting agriculture. The community is not skilled in anything else. Most children there are first-generation learners.*". The stakeholders who work outside are a part of the unorganized sector, and the jobs are not regular. The change in income level at different seasons (Figure 15) indicates the same; also it explains how different external factors influence this phenomenon like weather, transport etc. Their livelihoods shaped their food systems, Sandeep Menon one of the experts, mentioned: "*availability of fish and allied edible crustaceans-prawns, crabs etc. is important to the stakeholders because it is a part of their diet*". This can be related to nutrition issues mentioned by the doctors.

Coming back to how this factor influences other dimensions. Due to the lack of proper skills, most of the residents do not earn well, but they do possess skills in their traditional occupations (agriculture, saltpans, fishing, sand-mining) and the majority wants government interventions to support those trades. Stakeholders are having a combined household income of 20000 INR (235 euros) per month. For the same reason, the newer generation also had to leave school at an early stage as the family do not have enough resources to support them (to pay for tuition, travel). As the community is shaped over these trades, the social relationships are based on this. A comparison of social cohesion on stakeholders involved in these trades with the stakeholders working outside concluded that stakeholders involved in those trades possessed higher social cohesion compared to the other groups.

Safety is the next important factor after livelihood. Safety here is not only in terms of threats due to a natural disaster (flood) but also in terms of access to livelihood activities (income) and other elements like (food, water, clean air). The direct measurement of the perception of safety is only done for the flood part. All others are indirect (measured from concerns mentioned by the sample population). Presence of

mangrove influences the perception of safety; 100 per cent of the sample population recognizes the flood regulation benefit of mangroves.

The stakeholders who are still involved in livelihood activities, presence and provision of different ecosystem service made them feel like they are safe as they have a secured livelihood which is not dependent on external factors (like seasonal issues with accessibility, availability of jobs outside).

I find the awareness regarding the regulating services very interesting; one of the stakeholders tried explaining it to us in layman's terms (Text box 8). In addition to all the benefits, all the values combined contributes to the sense of place.

Respondent 65 years old (Fisherman): - "Mangroves help the ground of the island remains tight".

Text box 7 Perception - awareness about regulating ES

5.2. Opportunities

As mentioned in the preceding section, there are multiple opportunities available for the major challenges faced by the stakeholders. Policy interventions and local credit systems to support the main livelihood activities (agriculture, saltpan, fishing, and sand mining) can enhance the objective conditions to an extent. Another opportunity is with health, water and access to food and other resources. Management interventions and development plans focus on provisioning ES will support health aspect through the sustainable provision of clean water and local production of food (nutrition). Proper management of the existing freshwater sources can improve both health dimension and water scarcity issues, as the major health concerns in the village are vector-borne diseases. These are sustainable and independent alternatives for the challenges.

Objective three explores the difference of opinion in ES available and changes. Both experts and the stakeholders recognize the opportunities and mentioned that it is important for their wellbeing. When the analysis went beyond the opinion of selected experts and to the grey literature, an interesting observation was made. When comparing the data collected and the grey literature available on about the island. Before the visit to the island, I came across a few newspaper articles and Facebook posts regarding the life of the stakeholders. The authors referred to the island as self-sustained, and the stakeholders are not relied upon the provisions from outside, but the study shows that this is not true. However, before a decade or two, it was true that they were self-sufficient, but not now. Now more stakeholders started travelling to the city for jobs; production inside has reduced to a very minimum quantity. Evidence for this is abandoned and unmanaged farm fields and salt pans. This difference in perception is important to notice, and it suggests a lack of proper studies or research on the potential of the study area.

5.2.1. Policies and Ecosystem services.

Policies on biodiversity protection through the coastal regulatory zone act impacted the life of the stakeholders who live in Panju a lot. In one hand, such national-level policies are for the common good and have good motives behind, and they are regulatory and informatory in nature. Also, they are based on large scale quantitative measurement (for example, biophysical assessment, monetary evaluation of ecosystem services) On the other hand, and it has impacted the lives of many communities. When investigated the environment-related policies, the use of socio-cultural values in decision making is still

missing. Given the diverse nature of ecosystems and stakeholders benefiting from them, complimentary instruments are required to address the issues of such national-level policies on poor and marginalized communities (Badola et al., 2015) (Annex: 8.1). The information collected clearly states that no such efforts made to understand the local level impacts, especially in relatively remote islands like Panju.

It is important to conduct studies on understanding, where, how, why, and when of the role of ecosystem services in the community. It helps in prioritizing services which are important for the community. In this case, it is the provisioning ecosystem services.

5.2.2.   Uses of ecosystem services information in informed decision making

This section includes information related to local decision making and how information related to ES can be operationalized in decision making at the local level. The study identified ecosystem services of importance and is, directly and indirectly, related to different dimensions of well-being ("functioning"). Capability is one concept which can be considered as something which stays in between and can translate the available resources into well-being outcomes. The study also assessed the capability of individuals. Here the capabilities refer to the real opportunities available and the capacity of the individual to access them.

In the case of Panju, it has enormous potential in the case of ES, which offers support to multiple dimensions of well-being. Figure 36 explains such potential. Provisioning ES, especially agriculture and salt pan, can not only build a strong local economy, but it makes the island self-sustainable. This finding is based on the conclusions derived from the study. It highlights the importance of qualitative evaluation of ES in local decision making and identifying key priority areas.

5.2.2.1.   Policy suggestions

Policy instruments need to be designed in a way to integrate these responses. These responses can help in the complex decision-making process. It integrates disparate and varied information's.

1. Non-monetary evaluations of ecosystem services and well-being need to be done on a micro level to understand the dependency of ES with the local community. It provides valuable information in decision making and prioritization.
    a. The values through participatory approaches can be used as a technique to convey the message of how important they are to the community.
    b. In this way, balance can be found between interests of the stakeholder and environmental protection.
2. Development plans should include the interests of the stakeholders at the local level. Also, it should be made in a way, it strengthens existing systems, not by building an entirely new system.
    a. Stakeholders capability should be considered during decision making. Development plans which are not accessible to the stakeholders with the capability they have will act in the opposite way
    b. Intensity assessment with participatory GIS can be operationalised as a tool to set land-use management priorities.
    c. In-depth understanding of the interlinked ecosystem and well-being factors can help the stakeholders who have a socio-economic disadvantage to identify opportunities for well-being

The policies and developmental plans should include proposals to alleviate or address the challenges faced by the stakeholders. Such policies and plans are more likely to be accepted by the stakeholders (Schmidt, Sachse, & Walz, 2016).

5.2.3. Integrated responses at the local level

Based on the observations made and referring to relevant pieces of literature, following local integrated responses are suggested to address challenges faced by the stakeholders (Badola et al., 2015; Chan, Satterfield, & Goldstein, 2012; Martín-López et al., 2012). These responses are based on three levels of logic, with respect to both individual and community level. One based on rationale, how is it going to address the challenges faced by the stakeholders. Two based on capability, how capable the stakeholders are in utilizing the opportunity. Three, how well it aligns with the existing norms (Schmidt, 2018). The suggestions on cooperatives ("b" and "c") proposed are inspired from Kartar Singh and RS Pundirs writings on co-operatives and rural development in India and Anand Kumar Ghosh's writing on co-operative movement and rural development in India (Ghosh, 2007; Singh kartar, 2000).

a) Integrating locally perceived values of ecosystem services in the local decision-making process. National-level policy needs to start recognizing such values as they are important for the wellbeing of communities like the one in Panju

b) Local food production (agriculture and fishing), saltpan works can be strengthened by building cooperatives and can be combined with tourism activities (aligning with the existing plans). For example, due to the small area and remoteness, availability of infrastructure, it is not possible for the farmers of the island to compete with the farmers outside. So, value-added products and other activities (like tourism) can be incorporated into the agricultural area in a way that the farmers also gets benefited. In addition, it supports sustainable tourism and leads to more opportunities in the island which the stakeholders can make use (as their skillsets are aligned with the same). Similar integration is applicable for both saltpans and fishing.

c) Proper management of saltpans provides regulating ES benefits which prevent flooding of the island. So, by building cooperatives and with the support of the local government, saltpans can be brought back to life, thereby supporting the objective conditions of life and enhancing the actual and perception of safety. The same is applicable to mangroves

d) The resilience of the island from social economic and environmental (flood) is possible through "b" and "c". As b is aimed at building a socially and economically resilient community through the creation of sustainable income sources, and "c" is aimed at building resilience from the flood (natural/environmental).

These policy responses aligns with targets of sustainable development goals, Table 10 explains how opportunities identified from the findings of this study can contribute to different SDG indicators (IAEG-SDGs, 2016). The order is based on relevance to the study and results

Table 10 Explains how the results and opportunities identified supports different

SDG goal	Target	Description
15 *Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss*	15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts	The study identifies different ES values at local level in a way that can be integrated into local policy making process aimed at recognizing opportunities for better life
16 *Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels*	16.7 Ensure responsive, inclusive, participatory, and representative decision-making at all levels	The study findings are inclusive, and the policy suggestions are participatory.
2 *End hunger, achieve food security and improved nutrition and promote sustainable agriculture*	2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	The opportunities identified addresses stakeholders concern about local food production. In addition, it suggestions are also made on protecting the agro-ecosystems.
1 *End poverty in all its forms everywhere*	1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social, and environmental shocks and disasters	The regulating ES and livelihood support through the provisioning ES builds resilience to the community and reduces their exposure to b climate, economic and social stress
8 *Promote sustained, inclusive, and sustainable economic growth, full and productive employment and decent work for all*	8.9 By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products	The conflict interest identified with respect to the tourism potential, can lead to more sustainable tourism plans which creates new opportunities and protects the saltpans.
6 *Ensure availability and sustainable management of water and sanitation for all*	6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate	Suggestion in management plans in water resources will address SDG target 6.5

6.   CONCLUSIONS AND RECOMMENDATIONS

In this chapter I concluded the findings of the research, followed by the limitations and recommendations for future research.

6.1.   Conclusion and reflection on study findings

This study aimed to explore the interlinks between ecosystem services and human wellbeing. In summary, the well-being of stakeholders is not primarily dependent on locally produced ecosystem services the dependency is on a much larger scale. However, changes in local ES had impacted their well-being to an extent. For example, the changes that occurred in the provisioning ES in the study area did not have any serious effect on the well-being of the stakeholders. In terms of relationship with well-being dimensions, two factors influence all dimensions directly and indirectly. They are livelihood and safety. Livelihood is considered as the most important by the stakeholders. Majority of the residents irrespective of the direct dependency with ES recognizes the major ecosystem services: agriculture, salt pans fishing and sand mining. Even though everyone recognizes the values, the presence of one ecosystem services does not have a linear relationship with the well-being outcomes of the stakeholders. The relationship and outcomes vary based on individual capabilities like livelihood activity, skill level, and education. Opportunities to enhance well-being through ecosystem services can be found using the non-monetary evaluation of ecosystem services and combining them with capability. The methodological approach of measurement at an individual level gives the freedom to analyse at different levels (community level and individual level) and support the decision-making process based on the requirement

The primary aim of this study is to explore the interlinks between ES and human well-being and how such information can better inform the decision-making process. Existing ideas of ES and well-being uses an aggregated perspective. In which the assumptions suggest that the combined availability of ecosystem services leads to well-being outcomes. Few assessments and conclusions in this study are driven from an aggregated perception, the study attempted to understand the capability at a supra-individual level. Assessments at multiple levels allowed drawing conclusion about contributions of ES to well-being in a generalized way is an overestimation. Explicit references to different groups based on the level of dependency need to be made.

The study compliments and contributes to existing reductionist approaches in exploring the interlinks between human wellbeing and ecosystem services. Novelty of the approach lies in the efforts made to bring in the capabilities of the stakeholders while exploring interlinks between ES and wellbeing at the local level. This study identified more effective opportunities which will lead to well-being.

6.2.   Reflection

The aim of the study was exploring the interlinks between ES and human wellbeing and operationalizing ES information in the local level policymaking process. The opportunities mentioned or the integrated policy responses suggested are in no way related to bringing back the traditional practices or supporting traditional life and livelihood. However, it is more towards making the process more inclusive and highlighting the importance of making the local policymaking process more inclusive and informed.

6.2.1.   Limitations and recommendations

- The selected approach gathered information at the individual level and tried to highlight its importance in the decision-making process. But the problem of conflicting interests between multiple stakeholder groups may pose challenges. Methodological advancement is required to address such wicked problems.
- The method was more focussed on human-centric view; inputs from the environmental and economic side will help to balance the gathered information and in formulating relevant policies. For example, how localised sustainable livelihood assessments and local environmental impact assessments needs to be conducted for more efficient use of this information.
  - For example: inclusion of monetary evaluation of marketed good (not non marketed goods like air and water) would have been beneficial to convey the ultimate message. For example, what could have been the total benefits of agricultural production per season or the same for the saltpan? This helps the stakeholders to realize opportunities better.

- The selected method was resource-intensive and time-consuming. This is due to 2 reasons one is the large sample size and two the extensive questionnaire. Methodological advancement is required to make the process easier and less time and resource intensive.
- Inclusion of focus group discussions can be used to gather information about common interest, instead of collecting all information at the individual level and aggregating.
  - Information gathering could have done in two stages to avoid confusions. Information gathering in two stages allows more flexibility in the data collection phase.
  - Purposive sampling method could have chosen to reduce the number of samples, this makes Data collection process less time consuming.
  - In this way number of questions can be reduced it reduces the pressure on both the respondent and the researcher

6.2.2.   Recommendations and future research scope

- This study is suitable to understand the major opportunities in wellbeing at the local level which can be operationalized with the help of ES information. However, but In-depth sector-oriented research can be done to understand the micro-level issues faced in each sector. For example, agriculture, the study can be done only with farmers to understand issues and opportunities related to farming.
- The idea of analysing wellbeing outcomes in a disaggregated need to be explored further, especially in the rural context. This study due to its methodological and time limitations did not managed to explore it deeper.
- Policies and development plans with a deeper understanding of capabilities of rural people and the opportunities available will help people to stay where they are instead of migrating to the city for better opportunities. This is very relevant with respect to the current issues with internal migration in India[36]

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[36] The Guardian article titled "India racked by greatest exodus since partition due to coronavirus"https://www.theguardian.com/world/2020/mar/30/india-wracked-by-greatest-exodus-since-partition-due-to-coronavirus) is an example of such chaos.

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8. ANNEXE

8.1. Annexe: List of environmental policies

List of environmental acts and policies of India examined for this analysis. (Adopted form a review paper (Ruchi Badola, Syed Ainul Hussain, Pariva Dobriyal & Shivani Barthwal (2015) Assessing the effectiveness of policies in sustaining and promoting ecosystem services in the Indian Himalayas, International Journal of Biodiversity Science, Ecosystem Services & Management, 11:3, 216-224, DOI: 10.1080/21513732.2015.1030694**)**

1. Acts and policies The Indian Forest Act
2. The National Forest Policy Forest Conservation Act
3. National Forest Policy Wildlife (Protection) Act Biological Diversity Act
4. Environment Protection Act National Environment Policy
5. National Biodiversity Action Plan
6. National Action Plan on Climate Change
7. Year of enactment Abbreviation

8.2. Annexe: Research matrix

Table 11 Table explaining different methods and variables used in the study. All the analysis was performed in spas and ARCGIS.

Research questions	Method	Variable
1 To understand the aspects of well-being as perceived by stakeholders (stakeholders and experts).		
1a. Evaluation of objective conditions of well-being.	*Multiple methods* Quantitative evaluation Qualitative evaluation	- Education level: - Skill level - Access and availability of food - Access to water frequency - The income per month
1b. Evaluation of subjective conditions of well-being.	*Multiple methods* Quantitative evaluation Qualitative evaluation	- Access and availability of food - Visitation to the doctor - Reason for visitation - Collaboration between residents - Good social relations - Perception about safety (natural disasters) - Sense of place and belonging - Perception about the future - Perception of quality of air - Perception about local decision-

		making system - Opportunities in decision making process - Opportunities in opinion
2 To understand stakeholder's perception about the benefits received from provisioning, cultural and regulating ecosystem services.		
2a) What benefits do stakeholders receive from nature?	*Multiple methods* Quantitative and qualitative Frequency tables.	- Employment - Past employment - Source of secondary income - PGIS narratives - ES Changes - Source of water - Perception about changes - What do you collect from nature? - Visitation to mangrove - Perception about mangrove - Reason for visitation
2b) According to stakeholders, where is the provisioning, cultural and regulating ecosystem services located?	Mixed method Participatory GIS Qualitative analysis	PGIS maps and LULC map prepared
2c) Do stakeholders perceive that the benefits received from ES changed? If so, what changed according to stakeholders?	Quantitative and qualitative Participatory GIS	Reason for changing occupation Ecosystem service changes Reason for not using the water sources Change in mangroves
2d) If the stakeholders perceive the benefits received from the ES changed, what are the drivers of change according to stakeholders?	Qualitative	Changes Reason for changing occupation Government regulations
2e) Do the ES benefits vary in different seasons? If so, what is the variation in benefits received according to stakeholders?	Qualitative	Seasonal variation in ES benefits
2f) Are there differences in perception between stakeholders and the experts about the benefits received, changes and drivers of change? If so, in which aspects?	Qualitative - analysis	Comparison of inputs received
3 To analyse which ecosystem services are crucial for well-being in stakeholder's perspective.		
3a) Which ecosystem services are	Quantitative and qualitative	Narratives from the experts and the

crucial for the well-being of the stakeholders?		stakeholders
3b. What are the differences when comparing, the scientific information available on ecosystem services with the perception of stakeholders?	Quantitative and qualitative	
4 How to integrate ecosystem service information in the policymaking process to enhance human well-being?		
4a. To reflect and conclude how ecosystem service information can be operationalized to enhance well-being at the local level.	By analysing the key findings	

8.3.   Annexe: Sample population

Sample
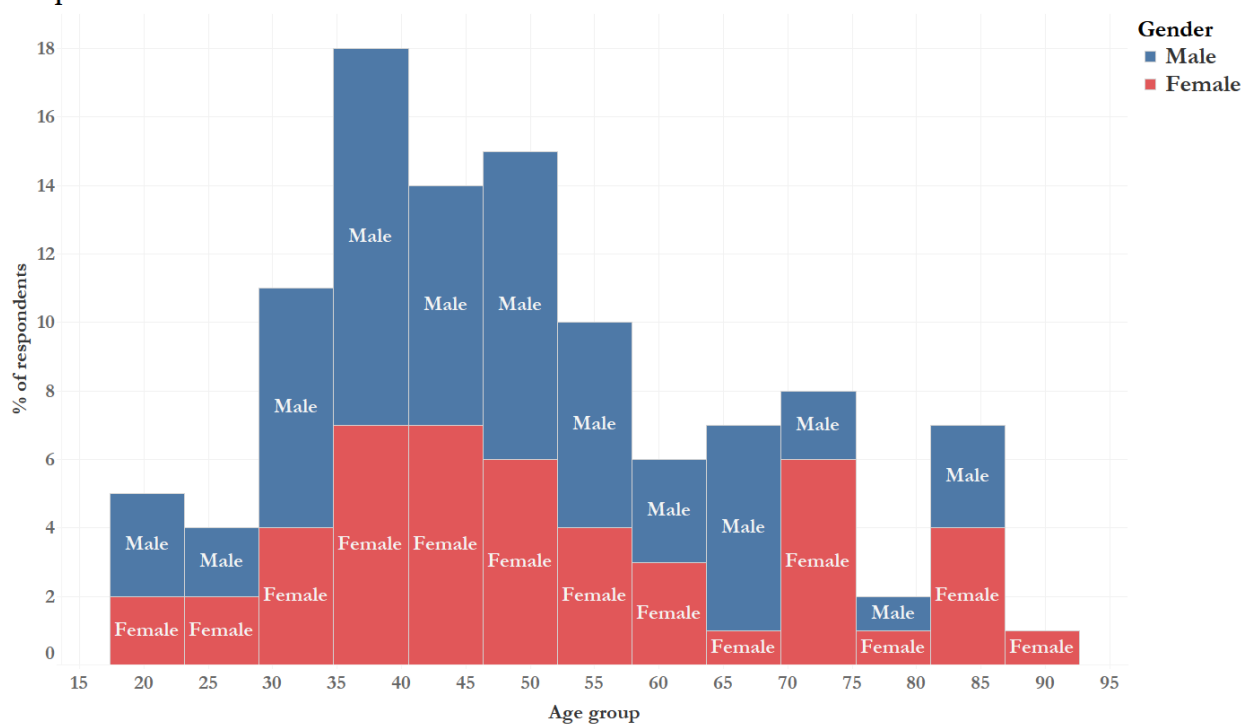
Figure 37 Sample population

ES survey

Introduction

Hello, my name is Anirudh from The University of Twente, Netherlands. Do you have some time to participate and answer some questions for us? The interview should take about half an hour. Before we start, I want to shortly tell you what we would like to talk to you about today. We would like to ask you some questions about the benefits you receive from nature and what role does it play in your life. Some people live and find work inside the island, and some go out and work. Because of this reason, people might perceive this benefit differently, and this is precisely what we are interested in. In answering our questions, there are no right or wrong answers; we are interested in your own experience. Of course, your name will be kept secret, and everything we talk about will be anonymous. If you have any questions during the interview or our questions are not clear, please let me know. Do you have any questions before we begin?

1. Write it here if the respondent has any questions before the survey.

   Section 1: Demographic characteristics

2. Are you the main income owner of the household?

   a. Yes

   b. No

3. How many adults live in your house?

4. How many children live in your house?

5. How long have you been living here? (In years)

6. Highest education level attained?
   a. Did not attend school
   b. Lower primary school
   c. Upper primary school
   d. High school
   e. Higher secondary
   f. Graduate and above

7. What is your current employment status?
   a. Employed for wages
   b. Self-employed

    c.   Out of work and looking for work

    d.   A homemaker

    e.   A student

    f.   Salaried

Section 2: Livelihood activities

8. If employed
    a. Employed outside the island
    b. Employed inside the island
    c. Self-employed inside the island
    d. Self-employed outside the island

9. How long you have been in this employment? (in years)

10. What is your occupation?

11. Do you or any of your family member involve in any job inside the island?

12. (In the past)
    a. Yes
    b. No

13. If yes
    a. Fishing
    b. Salt pans
    c. Agriculture
    d. Aquaculture
    e. Livestock
    f. Fuelwood
    g. Foraging
    h. Others

14. If others (please specify)

15. Why did you move to new employment?
    a. I needed more income
    b. Due to new rules and regulations
    c. Affected by natural disasters
    d. Land use / ownership change
    e. Others

16. if others (Please specify)

17. Apart from your main source of income are you involved in any other trade?

a. Yes

b. No

18. If yes

    a. Fishing

    b. Salt pans

    c. Agriculture

    d. Aquaculture

    e. Livestock

    f. Fuelwood

    g. Foraging

    h. Others

19. If others

    a. 1000 – 10000

    b. 10000 – 20000

    c. 20000 – 30000

    d. 40000 – 50000

    e. Above 50000

20. What is your monthly household expense? within a specified range

    a. 1000 – 10000

    b. 10000 – 20000

    c. 20000 – 30000

    d. 40000 – 50000

    e. Above 50000

21. Does your income vary in different seasons?

    a. Yes

    b. No

    c. I am not sure

22. If yes, how it varies in different seasons?

    (5= High income, 1 = Low income).

    a. Summer Season (starts in the months of April and ends in June.)

       1   2   3   4   5

    b. Rainy Season (from the month of June or July till the mid of September)

       1   2   3   4   5

    c. Winter Season (the season falls between the months of October to January)

       1   2   3   4   5

    d. Spring Season (occurs between February and March)

       1   2   3   4   5

    e. What is the reason behind this variation?

       1 2 3   4   5

Section 3: - Health

23. How often did you visit the doctor? (in the past 3 months)

24. What was the reason behind the visit?

25. What did the doctor mention as a reason for this visit?
   1. Water quality
   2. Nutrition (Food)
   3. Air quality
   4. Weather
   5. Others

26. If others (please specify)

Section 4: - perceptions

27. Given a chance, do you wish to move out of the island?
   a. Yes
   b. No
   c. I do not know
28. Why/ why not?
29. 15. Select from 1 to 5 (1 = I completely disagree; 2 = disagree; 3 = No opinion; 4 = agree, 5 Completely agree) your level of agreement with the next statements about the life in your town.
   a. is a safe place to live
      1   2   3   4   5
   b. have enough access to food
      1   2   3   4   5
   c. I have enough access to fresh water
      1   2   3   4   5
   d. I think it is probable that a natural accident in the area could happen in the future
      1   2   3   4   5
   e. The water and air are clean and free of pollution There are good relations among the neighbours in the village
      1   2   3   4   5
   f. We work and collaborate to improve the village
      1   2   3   4   5
   g. The village managers or politicians take into account my opinion
      1   2   3   4   5
   h. I have the opportunity to participate or express my opinions
      1   2   3   4   5
   i. my opinion in the decision-making process
      1   2   3   4   5
   j. I participate in Gram-Sabha
      1   2   3   4   5

k. I am satisfied with the quantity of water am satisfied with the quality of water

1   2   3   4   5

60. What improvements do you suggest in making this island a better place?
          (Follow-up Hints – Current opportunities in the island Alternative options and consequences)

62. What role can you play in bringing these changes? And why?
63. Start PGIS section
          I asked PGIS questions and marked responses in the paper
          OK
64. Do you think that these services changed over time?

        a) Yes
        b)   No
        c) I don t know

65. (Ask to mark P3)
66. Is there any freshwater source on the island? (If yes ask the respondent to identify it on the map)

        a) Yes
        b)   No
        c) I don t know

67. (Ask to mark P1)
68. Was there any freshwater source available inside the island? (If yes ask the respondent to identify it on the map)

        a) Yes
        b) No
        c) I don t know

69. (Ask to mark P2)
70. If yes, why are you not using it now?
71. Do you think the water source can be used with better management practices?

        a) Yes
        b) No

72. According to you what do you consider as a reason for this change?
73. How did the changes you mentioned above affect your life in the island?
74. How do you imagine your life without one or more of the services as mentioned.

Section 5: Sanitation

75. Does the dwelling have a latrine?
   a) Yes
   b) No

76. Where is the latrine located?
   a) Inside or attached to dwelling
   b) Elsewhere on-premises
   c) Outside premises (Public toilet)
   d) Open defecation

77. Are there signs that the latrine is in regular use? (Following questions needs to be answered by the researcher)
   a) Yes
   b) No

78. Is the solid waste container covered?
   a) Yes
   b) No
   c) No solid waste container

79. Is refuse lying on the compound?
   a) Yes
   b) No

80. How do you dispose of your solid waste?
   a) A waste pit in my yard
   b) A waste pit/dump outside my yard used by other households
   c) In my yard without using a pit
   d) Burned in my yard
   e) Dumped anywhere outside my household
   f) Others

81. If others (please specify)

82. Are you dependent on local environment for food?
   a) Yes
   b) No
   c) I used to collect before but not now.

Section 6: Freedom of choice and participation

83. If the respondent answers, "I use to collect before but not now" Why?
84. What do you collect?
85. Do you or any of your family members still work on salt pans?
   a) Yes
   b) No

86. Did the government intervention and regulations related to salt pans affect your life?
   a) Yes
   b) No

           c) I am not sure

87.   If yes how?

88.   From where do you get fresh water?

           a) Pipeline

           b) Other sources

89.   If others

90.   How often you receive water? (per week)

Section 7 Mangrove

91.   How often do you visit mangrove forest? (in a month)

         Please show it to us in the map

92.   (Ask to mark P6)

         OK

93.   What kind of resources do you gather from these ecosystems?

94.   How vital are mangrove ecosystems to you?

95.   Are you aware of any changes in these mangrove ecosystems over the past 50 years?

           a) Yes

           b) No

           c) I am not sure

96.   If yes, what do you think about the mangrove quantity?

           a) It increased

           b) It decreased

           c) Not sure

97.   If yes, what do you think about the mangrove quality?

           a) It increased

           b) It decreased

           c) Not sure

98.   What do you believe caused these changes? Natural or human causes?

           a) Natural causes

           b) Human causes

99.   Explanation on drivers of change

100.   Are you concerned about these changes?

           a) Yes

           b) No

106.   Why/why not?

107.   How have these changes affected your livelihood?

108.   What are the government schemes available to the stakeholders?

109.   What kind of benefits do you or your family members receive from the government schemes?

110.   Name the benefits and schemes available

111.   Are you aware of any new development plan?

104.   Gender Identity

           a) Male

           b) Female

c) Others

105.   May I ask how old you are?

8.5.   Annexe: Interview guides

Interview guide - Expert interviews (Experts involved in scientific research or social work)

Interview Guide (approximate time: 30-60 minutes)

Please remember that you can stop the interview at any time and that you may choose not to answer any question that you do not feel comfortable answering. With your permission, I would like to record your answers on this recorder. Are you ready to begin?

(A satellite image of the study area will be used to mark and identify important locations during)

General Questions

1. **What is your area of interest?**
2. **Please describe your involvement in similar projects.**
3. **In your perception, what is ecosystem services?**

Ecosystem Services

1. **Name up to three of the most essential tangibles, material benefits from nature that you feel very important for the residents of the study area.**

   Panju

2. **Name up to three of the most essential non-tangibles, non-material benefits received by the residents of the study area.**

   Probing questions – Regulating ecosystem services

3. **Are you aware of any cultural values assigned to any landscape in the study area?**
   Probing questions – Tourism potential
                        Spiritual values

4. **Of the benefits that you have mentioned, which one do you think is most important for the stakeholders**?

   In terms of livelihood etc
   - Why?

5. **If asked to elaborate: For example, is there a particular plant or animal that people consume, sell, or may use for other purposes such as a cultural celebration?**

6. **Can you show us the locations of different activities taking place within the island?**

Well-being

1. **In your opinion, what does the community need for a better life?**

2. **On a professional and economic level, do you think the study has enough resources to for creating better livelihoods?**

    a. *If yes: How? Positively, or negatively, or a mix of both?*

3. **Do you think the well-being of people has changed over time? If yes, why? And what caused the change?**

4. **What are your observations about the quality of life in the study area?**

    a. *Needs & demand*
    b. *Water*
    c. *Sanitation*
    d. *Health*

5. **Do you think the current occupation of people will bring them a good quality of life?**
    a. *What can be done for a better life in the study area?*

6. **Do you think the residents of the study area are safe?**
    a. *Why? If asked to elaborate: For example, safety and security regarding economic situation, exposure to natural disasters, and other issues (please specify)*
    b. *Do you think nature can contribute to the feeling of safety and security?*
       - *Nature-based solutions*
       - *Income source*
       - *Other nature-related entrepreneurial initiatives*

7. **Do you think the study area has an identity associated with nature or natures benefits to people?**
    a. *If asked to elaborate: Has nature has changed and how that affects the life of people living there?*
    b. *Name up to three benefits from nature that has changed compared to the past, and how?*
    c. *Discuss how nature's benefits have impacted your material needs and overall well-being*

8.6. Annexe: PGIS exercise

This section includes outputs of PGIS exercise (The hand drawn maps were digitally coloured to make the responses visible),

Figure 39 PGIS Example 2

Figure 38 PGIS Example 3

8.7. Annexe: Statistics: difference in perception

Table 12 Exploratory statistics explaining the difference in perception among different group of stakeholders.

Difference in perception			
			Statistic
Opportunities in decision making process	Self-employed inside the island	Mean	3.75
		Median	4.50
		Variance	3.583
		Std. Deviation	1.893
	Self-employed outside the island	Mean	2.78
		Median	3.00
		Variance	3.007
		Std. Deviation	1.734
		Minimum	1
	Employed outside the island	Mean	3.44
		Median	4.00
		Variance	2.042
		Std. Deviation	1.429
	Employed inside the island	Mean	2.94
		Median	2.50
		Variance	2.596
		Std. Deviation	1.611
I participate in Gram-Sabha	Self-employed inside the island	Mean	4.00
		Median	5.00
		Variance	4.000
		Std. Deviation	2.000
	Self-employed outside the island	Mean	4.44
		Median	5.00
		Variance	1.085
		Std. Deviation	1.042
	Employed outside the island	Mean	3.92
		Median	5.00

		Variance		2.020
		Std. Deviation		1.421
		Minimum		1
		Maximum		5
	Employed inside the island	Mean		3.31
		Median		3.50
		Variance		2.896
		Std. Deviation		1.702
The village manager takes my opinion into account	Self-employed inside the island	Mean		4.00
		Median		4.50
		Variance		2.000
		Std. Deviation		1.414
	Self-employed outside the island	Mean		2.33
		Median		2.50
		Variance		1.647
		Std. Deviation		1.283
	Employed outside the island	Mean		3.18
		Median		3.00
		Variance		1.835
		Std. Deviation		1.355
	Employed inside the island	Mean		2.50
		Std. Deviation		1.592
		Minimum		1
		Maximum		5
We have good relationship with the neighbours	Self-employed inside the island	Mean		5.00
		Median		5.00
		Variance		0.000
		Std. Deviation		0.000
	Self-employed outside the island	Mean		3.00
		Median		3.50
		Variance		3.647

			Std. Deviation	1.910
	Employed outside the island	Mean	3.49
		Median	5.00
		Variance	3.099
		Std. Deviation	1.760
		Maximum	5
	Employed inside the island	Mean	3.13
		Median	3.50
		Variance	3.317
		Std. Deviation	1.821

				Statistic
We collaborate with each other - is same across stakeholders' working inside the island and outside the island.	Self employed inside the island	Mean	**4.00**
		Median	**4.00**
		Variance	**0.667**
		Std. Deviation	**0.816**
	Self employed outside the island	Mean	**3.11**
		Median	**4.00**
		Variance	**3.281**
		Std. Deviation	**1.811**
	Employed outside the island	Mean	**3.28**
		Median	**3.00**
		Variance	**2.945**
		Std. Deviation	**1.716**
	Employed inside the island	Mean	**3.00**
		Median	**2.50**
		Variance	**3.200**
		Std. Deviation	**1.789**

8.8.   Annex: List of ecosystem services

Table 13 showing compiled list of possible ecosystem services, the list was used later to select final list Ecosystem services of importance

Provisioning ES	Cultural ES	Regulating
Hunting prays **Gathering/ picking up goods** **Fishing** **Seafood** **Timber** **Fuel / wood** **Medicinal & cosmetic plants** **Livestock** **Agriculture production** **Aquaculture** **Freshwater** **Fibre crops** **Tree plantations**	- Tourism/Ecotourism - Landscape beauty - Education / interpretation - Scientific research - Traditional Ecological Knowledge - Sense of place - Cultural heritage - Religious / spiritual	- Soil retention & Erosion control - Hydrological regulation - Pollination for useful plants - Climate regulation - Soil purification - Waste treatment - Water purification - Flood buffering - Pest prevention - Invasive species prevention - Air quality - Habitat maintenance - Food web maintenance - Nursery - Saline equilibrium - Climate regulation

8.9. Annexe: CRZ map and regulations

Source: https://mczma.gov.in/czmp
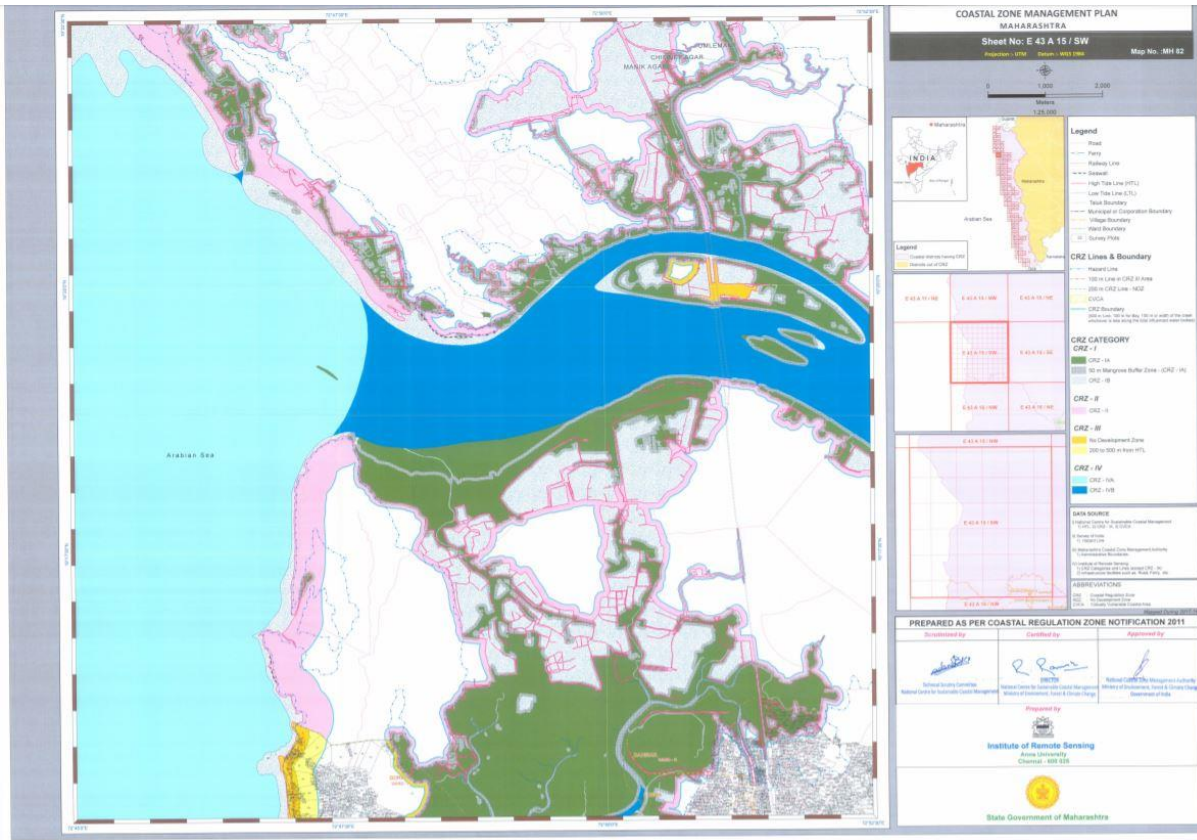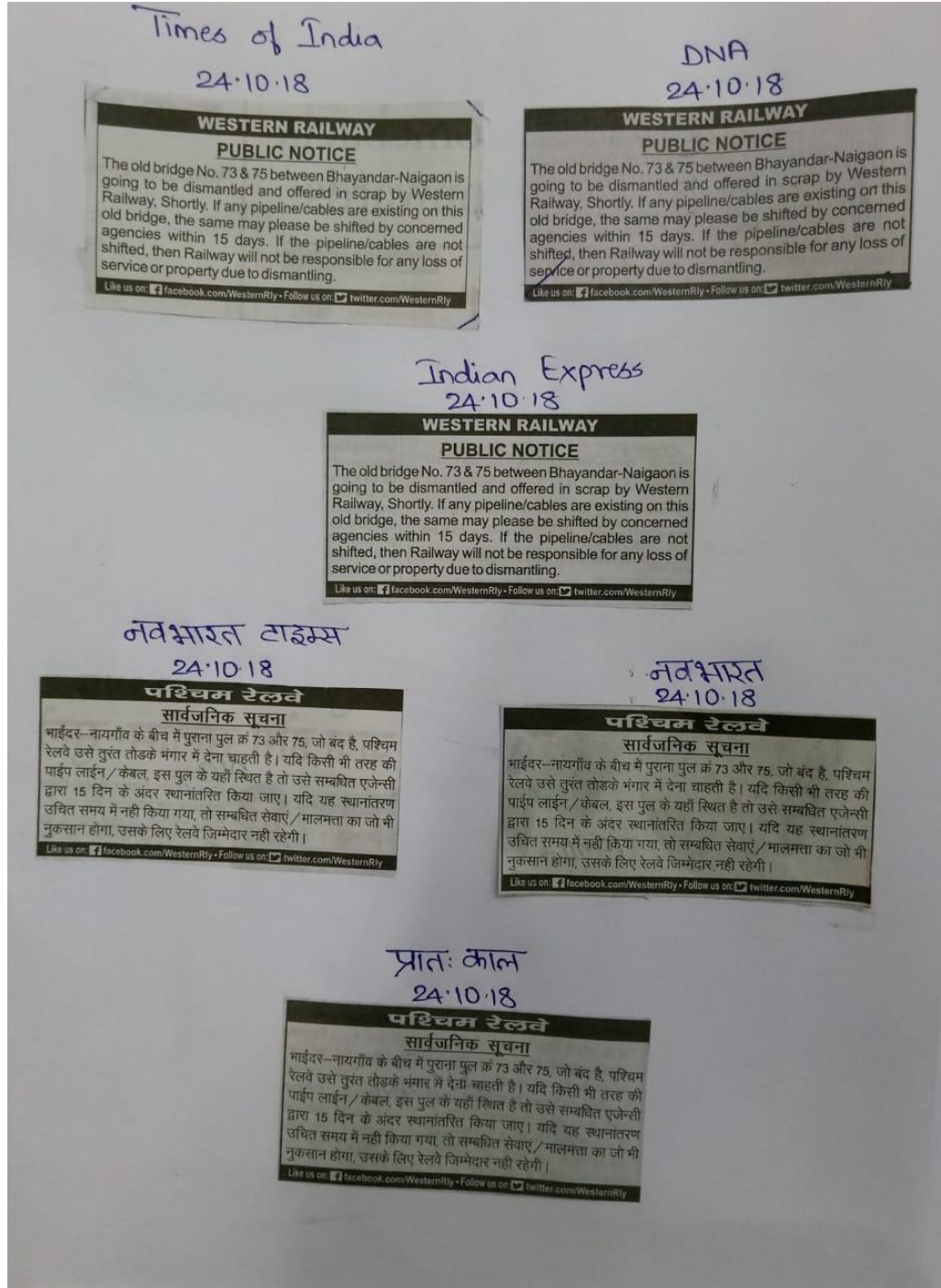Maharashtra coastal zone management authority

Figure 40 CRZ map showing most the land area in the study area as protected area.

8.10.   Annexe : Public notice by the western railway about demolishing the old bridge

Times of India
24.10.18

WESTERN RAILWAY
PUBLIC NOTICE
The old bridge No. 73 & 75 between Bhayandar-Naigaon is going to be dismantled and offered in scrap by Western Railway, Shortly. If any pipeline/cables are existing on this old bridge, the same may please be shifted by concerned agencies within 15 days. If the pipeline/cables are not shifted, then Railway will not be responsible for any loss of service or property due to dismantling.
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DNA
24.10.18

WESTERN RAILWAY
PUBLIC NOTICE
The old bridge No. 73 & 75 between Bhayandar-Naigaon is going to be dismantled and offered in scrap by Western Railway, Shortly. If any pipeline/cables are existing on this old bridge, the same may please be shifted by concerned agencies within 15 days. If the pipeline/cables are not shifted, then Railway will not be responsible for any loss of service or property due to dismantling.
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Indian Express
24.10.18

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नवभारत टाइम्स
24.10.18

पश्चिम रेलवे
सार्वजनिक सूचना
भाईंदर—नायगाँव के बीच में पुराना पुल क्रं 73 और 75, जो बंद है, पश्चिम रेलवे उसे तुरंत तोडके भंगार में देना चाहती है। यदि किसी भी तरह की पाईप लाईन / केबल, इस पुल के यहाँ स्थित है तो उसे सम्बधित एजेन्सी द्वारा 15 दिन के अंदर स्थानांतरित किया जाए। यदि यह स्थानांतरण उचित समय में नही किया गया, तो सम्बधित सेवाएं / मालमत्ता का जो भी नुकसान होगा, उसके लिए रेलवे जिम्मेदार नही रहेगी।
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नवभारत
24.10.18

पश्चिम रेलवे
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प्रातः काल
24.10.18

पश्चिम रेलवे
सार्वजनिक सूचना
भाईंदर—नायगाँव के बीच में पुराना पुल क्रं 73 और 75, जो बंद है, पश्चिम रेलवे उसे तुरंत तोडके भंगार में देना चाहती है। यदि किसी भी तरह की पाईप लाईन / केबल, इस पुल के यहाँ स्थित है तो उसे सम्बधित एजेन्सी द्वारा 15 दिन के अंदर स्थानांतरित किया जाए। यदि यह स्थानांतरण उचित समय में नही किया गया, तो सम्बधित सेवाएं / मालमत्ता का जो भी नुकसान होगा, उसके लिए रेलवे जिम्मेदार नही रहेगी।
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8.11.   Annexe : Challenges & Solutions: Semi-structured interviews with stakeholders.

Major challenges faced so far are during the fieldwork, are with the questionnaires[37] and interactions with stakeholders. Challenges and issues with the questionnaires were managed with the help of comments from the local NGO[38] and observations made during the pilot interviews. Many changes had to be made, to the structure of the interview, and the questions. Issues with communication were solved with changing the research assistants.

8.11.1.   First iteration: Pilot interviews.

The first version of the questionnaire had many open-ended questions. The respondents were taking more time to understand and reply. Also, the respondents were not giving proper answers or narratives to some crucial questions. Additionally, the time of the first visit was not good, it was in the afternoon, and most people were not available in their houses. Some terms in the first draft of questions created confusions and people were not able to recognise, for example, ecosystem benefits, living environment, or natures benefits. Even if they recognise the benefits, some found it very hard to recollect the benefits and describe them. Similar issues were faced in multiple parts of the semi-structured interview. From the first iteration, I understood that more specific questions had to be made. Also, I should not put pressure on the respondents to think and answer.

Corrections to the first iteration were made with the help of the comments, observations, and discussions with staff from a local NGO (SPARC) In the first iteration, we changed the structure of how the questions are arranged and changed the questions to more specific ones. For example in the first draft, we asked questions like "what are the benefits you receive from nature", "What do you think about the benefits received" etc., this had to be changed as I observed the struggle and time taken for answering the questions. During the first visits and interaction with the stakeholders' in august and in the first weeks of December, I made a list of possible answers which I thought I would receive from the stakeholders. I included this in the questionnaire, so instead of asking them what benefits you receive from nature, Question included a list of benefits and the respondents chose from the list and described them. Similar changes were made to many questions.

8.11.2.   Second iteration

2nd iteration also did not go well. I observed still some questions had a broader scope and was going through more than one topic; this was also creating confusions and taking more time. For example, "what do you think about the new government plans do you support them". Such questions had to break down and asked differently. Another challenge was with the map used for participatory GIS part. Stakeholders found it difficult to recognise the direction and location just with roads. This was solved by introducing a new map with few landmarks like a temple.

8.11.3.   More challenges

Even after the corrections and modifications, stakeholders were hesitant to talk. The initial observation was it was because of the language issue, but also with the help of the research assistant (Marathi), it was not working well. Panju is a socially isolated community, and they still feel insecure with outside people. Also, the stakeholders speak a different dialect of Marathi. So, I planned the next visit with students from

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[37] First version of the questionnaire failed to perform well due to many reasons, like usage of some words, some questions had a very general meaning to it etc.
[38] Staff members from the local NGO (SPARC), Maria lobo and Sharmila, helped to frame a few questions and to change a few parts.

KRIVIA who belongs to that Vasai and Borivali region (close to Panju). When the discussion was changed to the resident's dialect of Marathi, then stakeholders started opening. I finalised the structure and questions after this visit.

Eye contact with the respondent is a major factor; without this, we cannot take the conversation forward actively. Data feeding in KOBO collect was creating such issues, and research assistants were not able to handle two things at the same time. So, we (I and the research assistants) created another rough document where we prepared a skeleton of questionnaires in the form of a conversation in the paper, and we wrote down all the responses in Marathi in the paper. To make the semi-structured interview active and engaging. After every interview, we entered the data into KOBO collect using the skeleton document.

We also faced issues with GPS signals, and recording location did not work in some cases. In such cases, we marked the house in PGIS map and later extracted those coordinates and included them in the database.

Images taken at the field
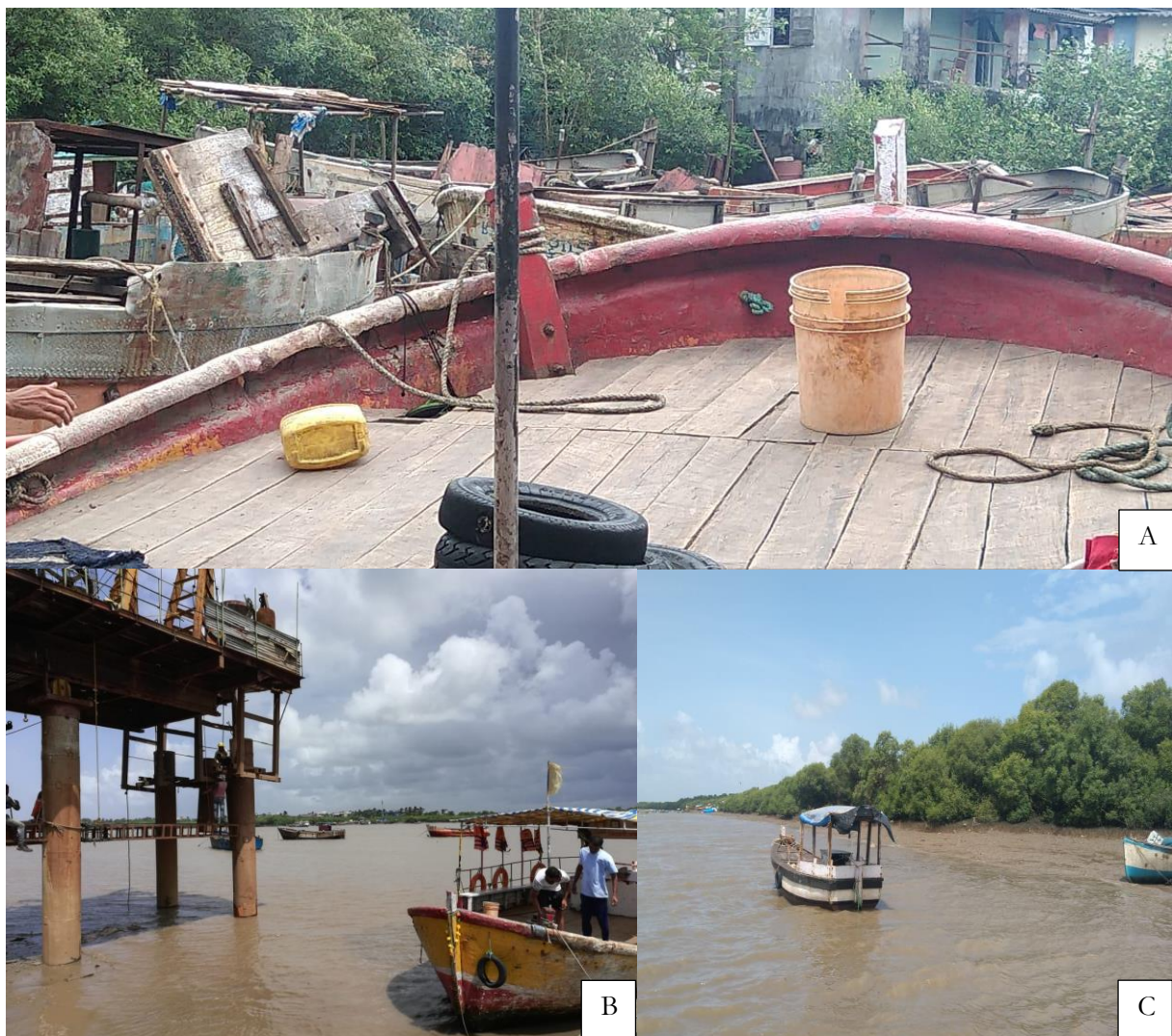
(A) The condition of boat which carries people every day, (B) Ongoing construction work of new bridge near the boat jetty, (C) Mangrove shield around the village

(A) Narrow and irregular streets inside the study area. (B) Example of complex structures of houses in the study area, (C) Abandoned and waterlogged agricultural area, (D) primary school Inside the study area