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Impact of Urbanization on Declining Mangrove Health of Goa

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Abstract

Mangrove ecosystems are dense forests along the tidal estuaries and comprise incredible biological diversity. Mangrove trees are salt tolerant and survive in muddy anaerobic soils by the presence of pneumatophores (breathing roots). Mangroves have crucial ecological and economic importance. They carry out the source and sink in the carbon cycle, and protect the coasts from floods, tsunamis and other disasters. Mangrove leaves and bark are potential sources of pharmaceutical compounds to treat AIDS, jaundice and cancer. However, unregulated urban development, increased pollution, altered distribution and national highway expansion, bridges and increased tourism has resulted in the most destructive impact on mangrove forest. In the present study, a field survey of mangrove sites in Goa like the areas of Cortalim, Ribandar, Old Goa, etc. has conducted to observe the mangrove morphology, and growing pattern and analyse the impact of urbanization on declining mangrove health. Further, a survey was conducted to track public awareness about the declining mangrove ecosystem. The individuals were divided into four different categories and five questions were asked including whether they are aware of mangroves, their occurrence, their decline, and measures to protect them. Results suggest that most people are aware of declining mangroves but haven't experienced mangrove declines in their locality. Most people suggest that creating awareness, building mangrove farms and implementing strict rules can help in conserving mangroves.

Keywords:

Mangrove, Urbanization, Declining, Awareness

1. Introduction

Mangroves are woody plants that generally have pneumatophores (breath in roots) and grow in regions between land and sea, mainly at the tropical and sub-tropical latitudes, where they exist in high salinity, extreme tides, strong winds, muddy conditions anaerobic soils. *(Adame M.F, 2021)*The term mangrove comes from the Portuguese words 'Mangue', a type of tree, and 'grove' refers to a group of trees. Thus, 'mangrove' may refer to the habitat as a whole or the trees and shrubs in the mangrove swampy. Mangroves grow in dense forests along tidal estuaries, salt marshes, and muddy coasts.

Mangroves extend over 18 million hectares worldwide. They cover nearly a quarter of the world's tropical coastline. *(Basha, 2018)* Thus, mangrove ecosystems are often called tidal forests, oceanic rainforests, or even coastal woodlands. Mangrove forests are an ecosystem of incredible biological diversity comprising hundreds of algae, molluscs, crustaceans, fish, insects, reptiles, birds, and mammal species. Saltwater crocodiles, pelicans, egrets, spoonbills, flying foxes and monkeys are all residents of mangroves.

Based on the location of a particular mangrove ecosystem, there are various zonation of mangroves formed. The zonation includes the Landward zone, Ceriops zone, Bruguiera zone, Rhizophora zone and the Seaward zone. *(Yuvaraji, 2017)* Individual species of mangrove trees have crucial ecological and economic importance. The mangrove ecosystem protects coastal regions from erosion, tsunami, and other extreme events. *(Ajai, 2013)*

However, mangrove forests have experienced severe destruction due to unregulated urban development, increased pollution, altered distribution, the National Highway expansion, bridges, and increased tourism. For instance, Goa state has witnessed a sharp decline in mangrove areas over the last three decades. The mangrove cover has declined from 20,000 hectares in 1987 to 2,200 hectares in 2015. (*Rodrigues*, 2020*)* Thus, there is an urgent need to take action to conserve the mangrove ecosystem.

Global support and public awareness could play a key role in succeeding in this aim of mangrove conservation. There is a minor success achieved too. As per the recent MoEF report of 2019, mangrove cover in India has increased by 1.10%. *(Indian State of Forest Report 2019, 2019)*. In the present study an attempt is made to analyse the impact of urbanization on mangroves of Goa and understand public awareness about the decline in the mangrove ecosystem.

2. Materials and Methods

2.1 Field Survey

A field survey was performed across Goa to observe the mangrove ecosystems and their decline due to urbanisation activities. The observations were restricted to visual analysis of live-mangroves and dead mangroves. It was evident that live mangroves had leaves, and birds and insects around. Whereas, dead-mangroves were completely black and devoid of any flora or fauna around.

The locations with Mangroves in Goa were selected using google maps. Among those Cortalim, (15°24'09.8"N 73°54'26.3"E) Mandovi (15.5049° N, 73.8344° E) Panaji (15°29'37.3"N 73°49'57.2"E) Old Goa (15.5352° N, 73.9578° E) and Ribandar (15.5059° N, 73.8642° E) were chosen. Ferry boats were used to get a clearer view of mangroves.

2.2 Questionnaire

A questionnaire-based survey mode was used to enquire local people across Goa to know about their views on mangrove decline and steps in its conservation. The questionnaire forms were distributed to people and responses were recorded. The survey was taken in four different age groups: Below 10 years, 11-25 years, 26-60 years, and 60+ years. The following questions were asked:

i. Name of person

ii. Age Group

iii. Are you aware about declining state of mangroves?

iv. Have you seen decline in mangrove in your area?

v. What according to you is major reason for mangrove decline?

vi. What could be the best and creative way to conserve mangrove?

Multiple choices were provided for the questions and an extra option was put up so that individual with different idea may express it. Options put up for major reason for mangrove decline included: Urbanization, climate change, natural decay and others.

The options put up for best and create ways to conserve mangroves included: Build concept of mangrove farming, construct mangrove resorts, fence areas as mangrove conservation sites, implement strict rules and actions, create more awareness and others. Many of the ideas were self-made and read through different articles. *(Shing Yip Lee, 2019), (Bloem, 2022), (Brenner, 2018)* etc.

2.3 Online Survey

An online survey was also prepared using google forms which had similar questions as that of questionnaire form. This online approach was used to know ideology of a larger audience in and outside Goa. The only additional questions asked were:

i. Which state you live in?

ii. Whether your state have mangrove?

3. Results

3.1 Field Survey Analysis

The field survey was performed across different locations in Goa. Adverse species of mangroves were observed and their morphology was observed. Some mangrove varieties observed belonged to genus of *Rhizophora, Bruguiera, Avicennia, Sonneratia, Exoecaria* etc.

Similar species level identification is described by Forest Department of Goa. As per their reports Goa has 16 mangrove species including *Rhizophora mucronate, Rhizophora apiculate, Bruguieragymnorrhiza, Bruguieracylindrica, Ceriopstagal, Kandeliacandel, Avicennia officinalis, Avicennia marina, Sonneratia alba, Acrostichumaureum, Sonneratiacaseolaris, Aegicerascorniculatum, Excoecariaagallocha, Acanthus illicifolius, Lumnitzera racemose* and *Derris heterophylla*. (*Mangroves in Goa, n.d.*)

From the field survey it was evident that unregulated urbanization has led to huge decline in mangrove populations. Regions like Cortalim and Panaji which are constant construction sites, had many dead mangroves. One of the possible reasons for mangrove deaths, as observed, could be blockage of water flow. But sites at outskirts Ribandar still have many mangroves conserved.

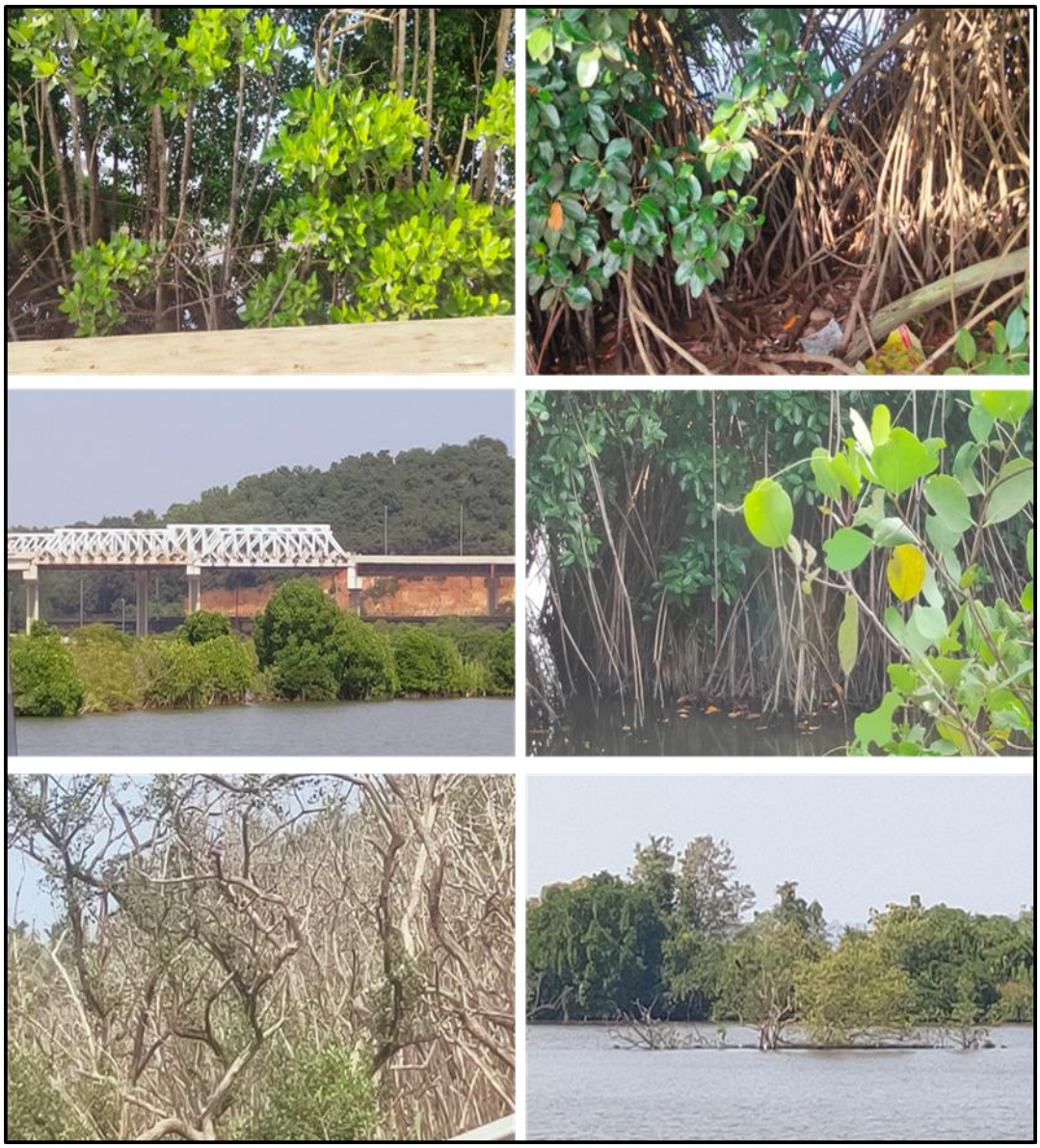
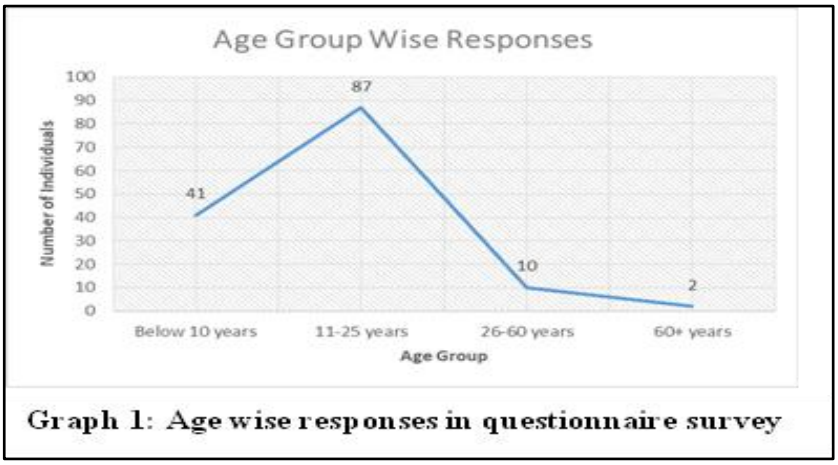


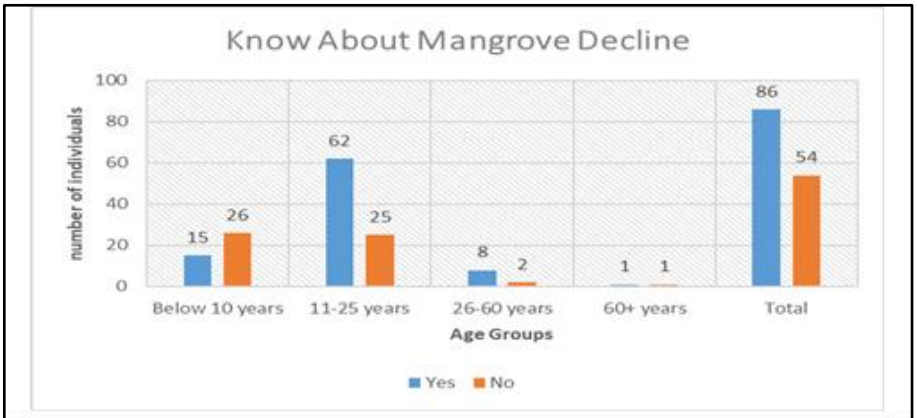
Figure 1: Field survey at Mangrove sites in Goa

3.2 Questionnaire Analysis

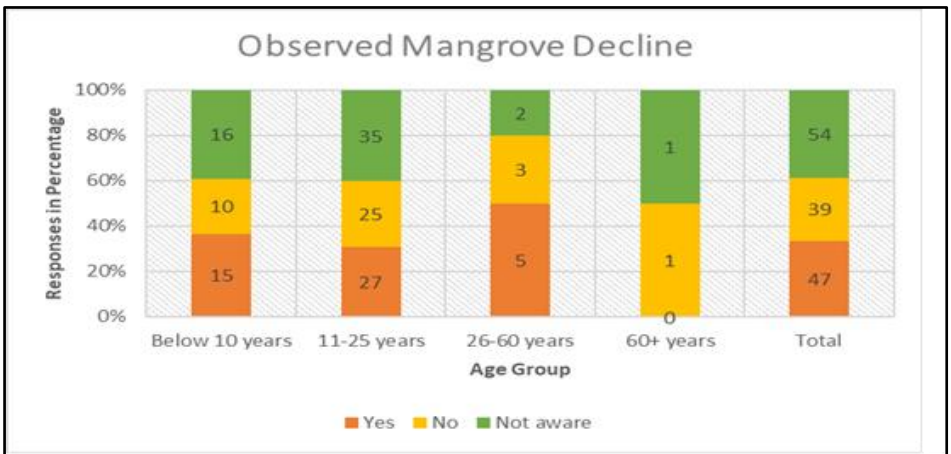
A total of 140 people from different age groups answered the questionnaire round. Among those, 41 individuals were in the age group below 10 years, 87 individuals were in the age group between 11-25 years, 10 were between age group of 26-60 years and 2 were 60+ years of age group. The graphs 1-5 visually represent the responses by the individuals.



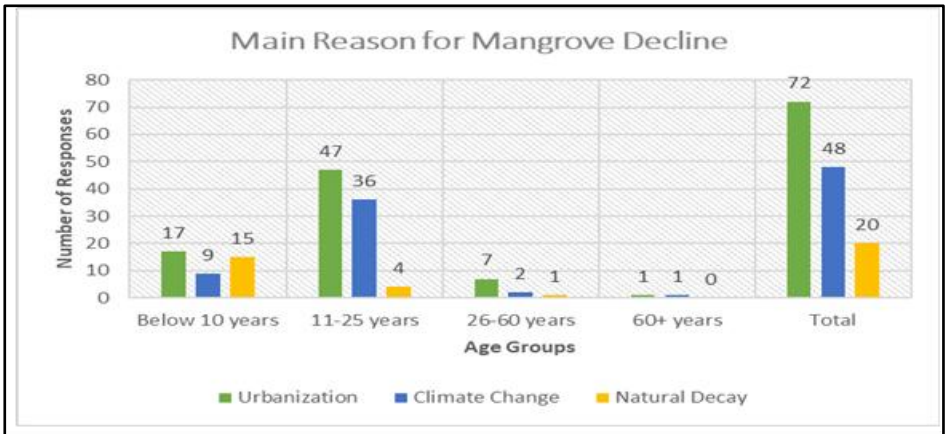
Graph 1: Age wise responses in questionnaire survey



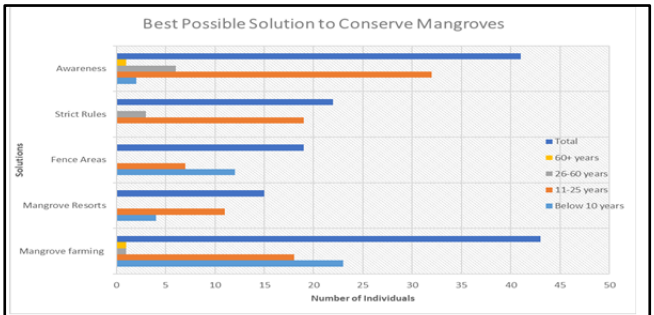
Graph 2: Questionnaire responses on whether they know about mangrove decline



Graph 3: Questionnaire Responses on whether they have observed mangrove decline



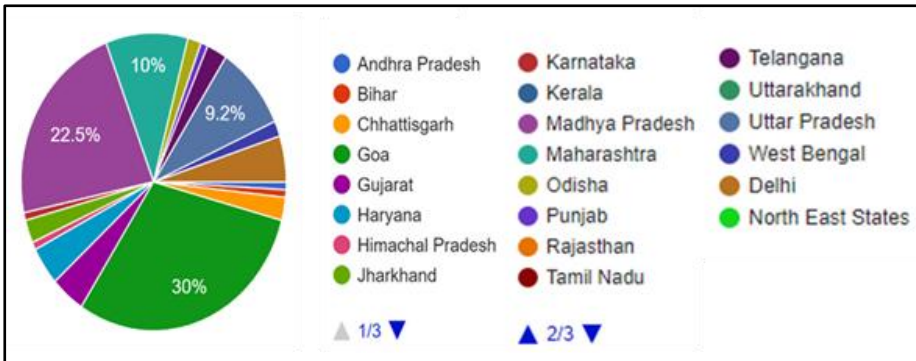
Graph 4: Questionnaire Responses on What could be the main cause of Mangrove Decline



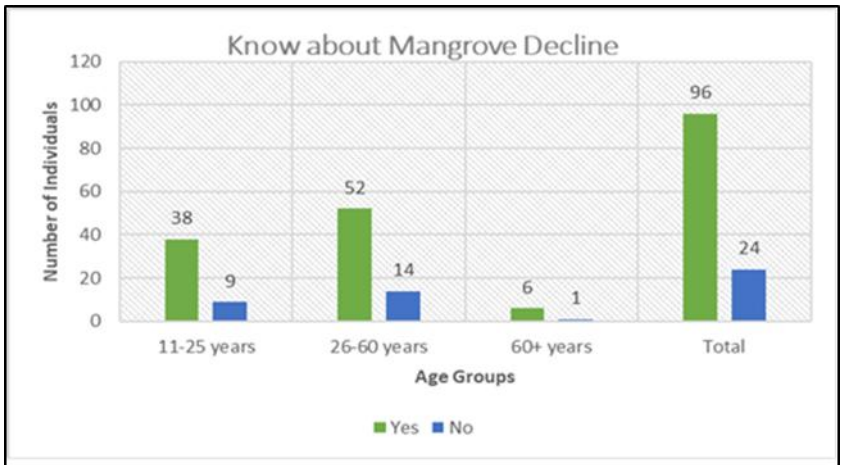
Graph 5: Questionnaire Responses on Best Possible Solution to Conserve Mangrove

3.3 Online Survey Analysis

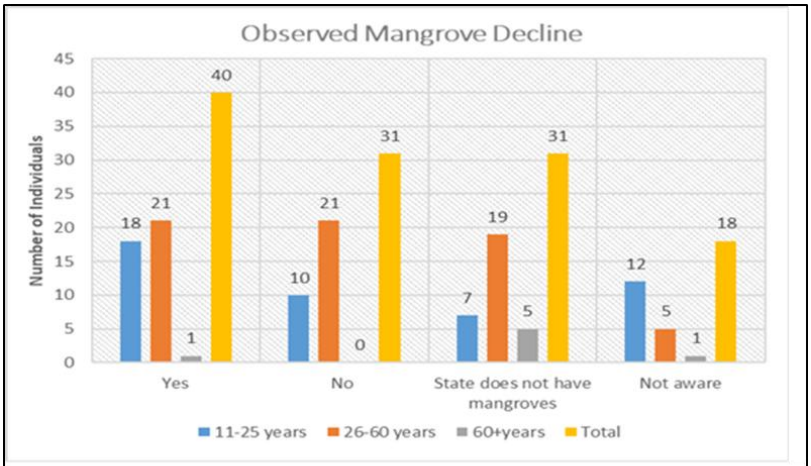
A total of 120 responses were recorded from different age groups using google forms. The people surveyed online belong to 17 different states of India. Among the responses, 47 responses were from 11-25 years age group, 66 responses were from 26-60 years age group and 7 responses were from 60+ years age group. The graphs 6-10 visually represent the responses by the individuals. In online survey responses under 'others' option was also observed. One novel response under best possible solution to conserve mangrove suggest to 'carryout urbanization in view that mangroves are not disturbed'.



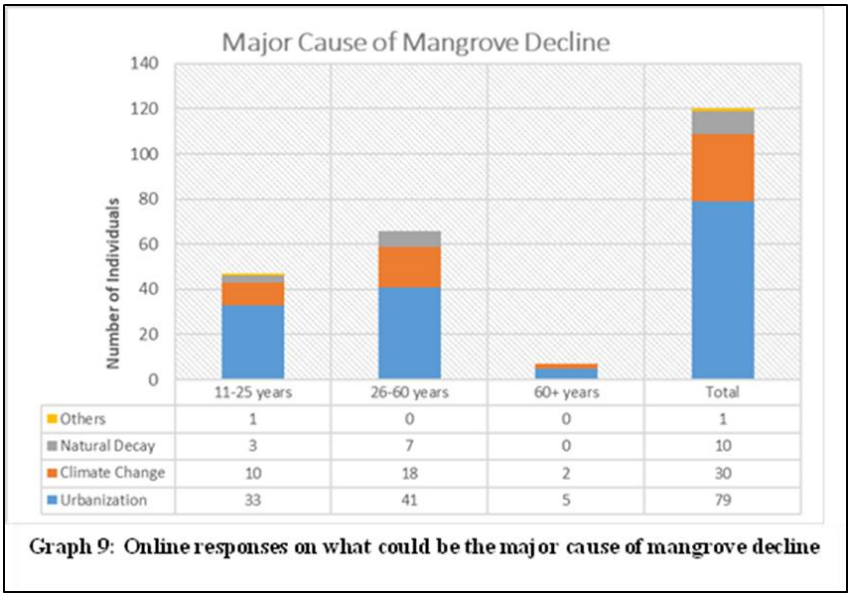
Graph 6: State wise Responses in Online Survey



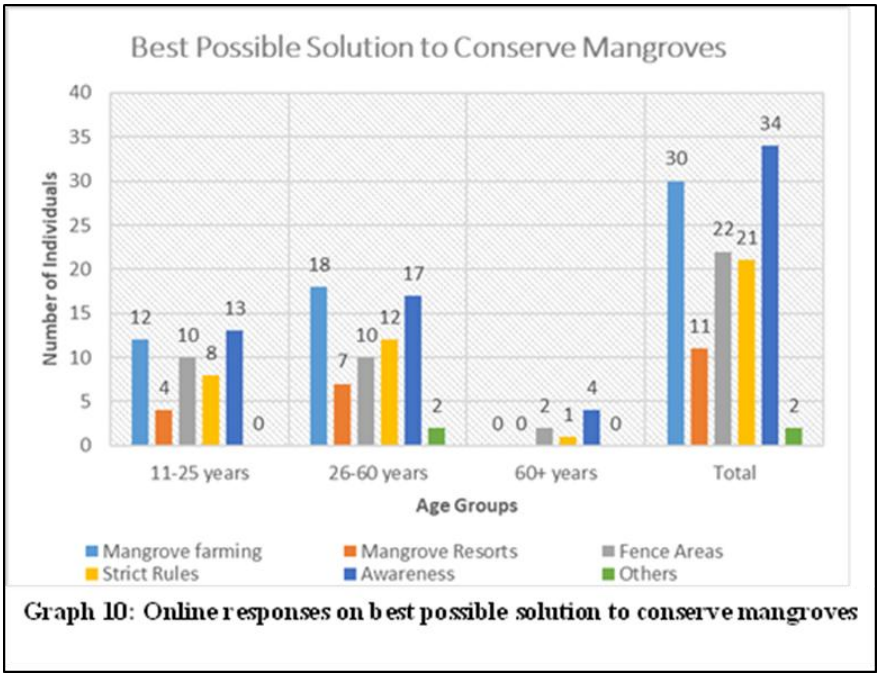
Graph 7: Online responses on whether individuals know about mangrove decline



Graph 8: Online responses on whether individuals have observed mangrove decline



Graph 9: Online responses on what could be the major cause of mangrove decline



Graph 10: Online responses on best possible solution to conserve mangroves

4. Discussions

From the field survey conducted at mangrove sites in Goa, various morphologies, adaptations and varieties of mangroves were observed. (*R.Vinoth, 2019)* described in depth analysis of physiological adaptations of mangroves to survive at high salt concentrations and anoxic conditions. However, it was evident that mangroves are dying due to anthropogenic activities majorly urbanization and constructions. During the field survey conducted at mangrove sites of Goa, many dead mangroves were visibly present.

A recent study conducted by *(Jyoti Prakash Hati, 2021)*also shows vegetation stress in the mangrove forests of Lothian Island of Sundarbans, West Bengal. Their study showed that in two years of experimentation (2016-2018) nearly 56% of area exhibited increased stress and mangrove decline. *(Krishnakumar Ponnambalam, 2012)*made use of remote sensing and GIS techniques to analyse changes in wetland ecosystem, particularly the mangrove cover at the Mullipallam creek area of Tamil Nadu over a period of 16 years. However, the cases of mangrove decline is not only limited to the India, many other research conducted by *(Juman, 2013), (Benavides-Varela, 2016), (Toosi, 2019), (Leempoel, 2013), (Kominoski, 2022)* suggest the declining health of mangrove ecosystem at Trinidad, Costa Rica, Iran, China and USA respectively.

The present work takes into account the general public awareness about mangrove and its present conditions. To the best of the knowledge, it is a unique study that represent age wise ideology of common public about mangroves. On the basis of questionnaire and online survey, it can be interpreted that many people are at least aware about mangrove's decline. However, there is a quite large section of young generations i.e., below 10 years age group and 11-25 years age group who are still unaware.

Further, upon data analysis, it is evident that majority of people surveyed believe that major cause for mangrove decline is Urbanization. This is followed by climate change. However, climate change by itself is a consequence of unregulated urbanisation and other human activities that disturbs the balance between humans and ecosystem. *(Malik, 2017)* also investigated that direct use of firewood, charcoal and construction are the major causes of mangrove forest decline South Sulawesi, an Indonesian Island. A similar finding (*Long, 2022)* also highlights that local residents induce mangrove forest destruction in northern Beibu Gulf, China.

Finally, from the data surveyed, six possible solutions to conserve mangrove forests and stop mangrove decline were obtained. These solutions included:

i. Building Concept of Mangrove Farming in which specialised farms could be created where mangroves can be planted.

ii. Construct Mangrove Resorts in which resorts, night stay cottages etc. can be built around mangroves to preserve them and also create awareness among visitors.

iii. Fence Areas as Mangrove Conservation Sites in areas, where mangroves are growing. These areas could be fenced as Mangrove Conservation Sites in order to protect them from invaders.

iv. Implement Strict Rules and Actions in which strict laws can be made and implemented for mangrove conservation.

v. Create More Awareness amongst people by conducting campaigns, surveys, presentations etc.

vi. Do Planned Urbanization such that no mangroves are harmed during construction.

The questionnaire and online survey analysis suggest that nearly 28.88% public is in the favour of creating more awareness and campaigns to tell people about mangroves, their importance and declining condition. Very close to it, 27.69% people surveyed believed that building the concept of mangrove farming can be an innovative way to conserve mangroves. *(Pham, 2022)* suggest to carry forward effective financial incentives to reduce mangrove losses in Vietnam. Recently, (*Sreelekshmi, 2021)* worked on Mangrove forests along the coastline of Kerala. They support the viewpoint of framing strict laws to conserve mangroves. The research also talks about community-based mangrove restoration programs for long-term conservation of mangrove ecosystem.

5. Conclusion

On the basis of field survey, study hypothesize that mangroves are declining rapidly in Goa. Questionnaire and online survey data analysis suggest that though many people are aware of Mangrove's decline, there are many more young generations (below 10-year age group and 11 to 25 years age group) who are still unaware. Results show that people are aware that urbanization is a major cause of mangrove decline. So, to stop this impact of urbanization on mangroves, they feel that creating more awareness and building the concept of mangrove farming will be helpful. The present study paves the way to further explore mangrove conservation strategies and inhibit the impact of urbanization on the mangrove ecosystem.

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