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PARTICIPATORY IN-SITU MANGROVE AFFORESTATION ACCELERATES LOCAL DYNAMICS

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It's a great pleasure and privilege to write a foreword for the action research bulletin on "Participatory In-Situ Mangrove Accelerates Local Dynamics". I congratulate the authors of the paper Dr Shisir Kumar Das and Mr. Proshin Ghosh for their indepth action research and successful realisation of the goal of the initiative. I am quite happy that Dr Das ,a social scientist par excellence has been immensely contributing for decades to enrich understanding of humanity at large in various domains of knowledge. As the Director of Indian Institute of Education and Care , he has already established

many significant milestones in the field of Development. I am also impressed by the scientific perspective of Mr Ghosh who has proved his mettle by delving deep in to the dynamics influencing climate change and in-situ development of mangroves. His long association with IGSSS has yielded many more achievements.

In the face of escalating climate change impacts and environmental degradation, the importance of community-led conservation initiatives cannot be overstated. This research document throws a light on the transformative power of participatory mangrove conservation, highlighting the critical role that local communities, including women, youths, and the elderly, play in nurturing and protecting these vital ecosystems.

Through a scientifically grounded and community-centric approach, this study demonstrates the potential of in-situ mangrove conservation to not only enhance ecosystem resilience but also accelerate local livelihoods. By empowering communities with the knowledge, skills, and capacity to manage and protect their mangrove resources, we can foster a sense of ownership and stewardship that is essential for long-term sustainability.

The findings of this research underscore the importance of inclusive and participatory approaches to environmental conservation. By engaging women, youths, and the elderly in mangrove conservation efforts, we can tap into the unique perspectives, experiences, and knowledge that each group brings to the table. This, in turn, can help build more resilient and adaptive communities that are better equipped to withstand the impacts of climate change, cyclones, and floods.

As we move forward in our efforts to combat climate change and promote sustainable development, this research serves as a timely reminder of the critical role that community-led initiatives can play in driving positive change. By supporting and scaling up participatory mangrove conservation efforts, we can help build a more sustainable and resilient future for generations to come.

I wish great success for the endeavour of Dr Das and Mr Ghosh for their unstinted efforts and indomitable willpower to explore more and more innovative avenues in the interest of mankind at large.



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Background

Odisha stands 6th for mangrove forest coverage with highest mangrove species diversity in India mainland. Until 1940s, Odisha's coastline was endowed with nearly 500 square kms of mangroves, which has now been reduced, through destruction, to 227 square kms (Nirmal Sahu, Asian Journal of Environment and Disaster Management, 2012). 35 true mangrove species belonging to 20 genre and 14 families (Ragavan et al., 2016) has been recorded from Odisha. According to India State of Forest Report, 2023, mangrove cover expanded by 2 square kms between 2021 and 2023. This reveals successful conservation and plantation efforts undertaken by Forest and Wildlife Department, Odisha. But in most cases, villagers' participation is dormant in undertaking pro-mangrove initiative with the department. Below are some of the practices of villagers adversely impacted on mangrove in the coastal Odisha

1. The primary livelihood of most of the coastal communities is fishing. The mangrove roots pose a barrier for the fishermen community to park fishing boats and other fishing equipment at the river shores. This results in an unending conflict between the fishermen community and mangrove.
2. The newly germinated mangrove seedlings on the river shore get uprooted and spoiled due to the overgrazing of village livestock. Mangrove seedlings are tasty and nutritious fodder for livestock. This disturbs natural regeneration of mangroves.
3. The illicit felling of mature mangrove trees for fuelwood collection leads to big lacuna in the mangrove patches at river shore.
4. Frequent perforations in the embankment for shrimp cultivation result in embankment breaches and distortion of mangrove diversity.



Mangrove is a special xerophyte propagated in the brackish water, safeguarding the coastal part of country from natural hazards with their strong root buttresses and can absorb four times more carbon-dioxide from the atmosphere than other trees. Most of the coastal village communities know the effectiveness of mangrove in minimizing coastal flood and cyclone risk. But they are exploiting mangrove for their livelihood and other basic needs. This reduces the coastal mangrove rampantly.

On the other hand, some facts and figures from International Energy Agency and Environmental protection agency, 2021 given below, conveys the truth on greenhouse gas emission globally. In 2018, per capita greenhouse gas emissions were highest in the United States and Russia while India was in the 8th position. Globally, the primary sources of greenhouse gas emissions are electricity & thermal power (31%), agriculture (11%), transportation (15%), forest fire (6%) and manufacturing (12%). Energy production of all types account for 72% of all emissions. CO₂ accounts for about 76% of total greenhouse gas emissions. Methane, primarily from agriculture, contributes 16% of greenhouse gas emissions and nitrous oxide, mostly from industry and agriculture, contributes 6% to global emissions.

Greenhouse gas, the emission of air, is responsible for the rising of the earth's temperature, i.e. global warming which leads to extreme climate events like floods, cyclones, heat wave etc which have several adverse impacts on human life and survivability.

As per The Paris Agreement, every five years, countries review and enhance Nationally Determined Contribution, the global commitment to reduce greenhouse gas emission and adapt to climate change. But this commitment is not sufficient to keep global temperature rising below 2.0 degrees unless the community and other stakeholders come forward with the Government to address air emission. Minimizing air emission has become a global priority to rescue life and the environment.

Indo-Global Social Service Society (IGSSS) in collaboration with DIAGEO, has undertaken in-situ mangrove afforestation initiative in Balipanthal and Birudipanthal villages of Nagara Gram Panchayat, Astaranga block, Puri, Odisha since 2023. This initiative is an extension of nature-based solution which addresses societal challenges through actions to protect, sustainably manage, and restore the village mangrove ecosystem, a gain for villagers and Nature at the same time. This solution addresses flood and cyclone risk, soil erosion, biodiversity loss and gives possibilities of alternative livelihood for the villagers.

The Super cyclone, October 1999, impacted massively on these two villages. Approximately, 580 households were destroyed, 10 casualties were reported, 243 persons were injured and 80% agriculture land faced extreme brackish water intrusion and lost fertility. As a result, the Forest and Wildlife Department, Odisha became highly stimulated in mangrove afforestation

to safeguard the coastal villages from flood & cyclone. At present ,around 25% of the coastline of both villages are enveloped by mangrove patches. (information source is local)

This literature is a remarkable value addition in mangrove domain resulted from a successful partnership between IGSSS as a technical partner & IIEC as a knowledge partner. It will give us an utmost understanding of pro-mangrove action research initiative which can accelerate the village dynamics including quality of life and survivability of the villagers.

Function and effectiveness of mangrove

Mangrove is the most significant flora species for mitigating the climate change risks through minimizing carbon-dioxide from the atmosphere. It has four times more carbon trapping capacity than other trees. Due to the unique adaptability, mangrove can survive in extreme hostile environments, such as high salt and low oxygen conditions in the coastline brackish ecosystem. Below are the adaptive features of mangrove which make mangrove forest resilient to extreme climate events in the coastline.

1. Underground tissue of any plant needs oxygen for respiration. But in a mangrove habitat, the oxygen in soil is very limited. This leads to the mangrove root system coming out above the ground to absorb oxygen from the atmosphere. The perforated root tips which come out above the ground are called breathing roots or pneumatophores.
2. Due to the prop roots, mangroves can withstand the shock of high tide and flood in the river.
3. Mangrove trees contain a complex salt filtration system and complex root system. The roots filter out 90% of the salt from soil. Some species of mangrove excrete salt through glands in their leaves.
4. Mangrove can store fresh water in their thick succulent leaves. A waxy coating on the leaves seals in the water and minimizes evaporation.



Viviparous germination



Pneumatophores of mangrove species



Prop roots of mangrove species



5. Mangroves are viviparous. Their seeds germinate while still attached to the parent tree. Once germinated, the seedling grows into a propagule. Due to the weight of the mature propagule, it fixes into the muddy soil when it drops from trees. This minimizes the risk of floating and loss of the seed during high tide.
6. Mangroves absorb atmospheric carbon and grow. When the leaves, stems and other remnants fall, it is buried under accumulating sediments of the river. Very low or nil levels of oxygen in the soil checks decomposition of the mangrove leaves and other remnants by microorganisms. Hence the carbon from the leaves and other remnants remain intact in the river sediments if it is not disturbed by human interference and storms. It has been revealed that out of the total carbon sequestration by a mangrove ecology, 20% carbon is sequestered in the green biomass (shoot part), 2% carbon is sequestered in the dead and downed biomass and the remaining 78% carbon is sequestered in the river sediments due to deposition of the mangrove leaves and other remnants in river sediments.

Transformation in the community

There are 200 households, in average, residing in each of both villages, with a substantial number of youths, elderly, children, men and women. Separate action research initiatives were taken with each of the sample group like youth, elderly, children, men and women. Apart from this, the role of Gram panchayat duty bearers was very impressive in the action research initiative. How each sample group transformed into crucial change makers in this research action initiative has been enumerated in the paragraphs below.

Teenagers and youth

The village teenagers and youth sample groups were one of the important groups. One-fourth of the village population in both the villages were teenagers and youth. Usually, teenagers and youth are expected to be highly enthusiastic, motivated, hardworking and smart, but ironically most of the teenagers and youth in both villages wasted daily time on android and were addicted to several bad practices. Due to limitations in agriculture and inadequate income possibilities, some talented teenagers and youth migrated to neighboring cities for earning. As a result, negligible participation was visible in the beginning of the action research initiative from the teenagers and youth.





IGSSS team prioritized village teenagers and youth since inception. Basic understanding on action research initiative was developed in the teenagers and youth while organizing several meetings and discussions by project team. The teenagers and youth became motivated with the vulnerability mapping exercise to identify village vulnerability and capacity and accordingly prepared mangrove plantation plan to address the extreme climate events. In addition, the quadrant study to identify the native mangrove species in the river shore enhanced their interest and their participation amplified. They attended several capacity building training courses and got involved in the steps of mangrove plantations in the rivershore like site selection, species selection, seed collection from surviving forest patches, plantation management, monitoring plantation health, caring and patrolling plantation etc. At present they are pro-active, they are taking leadership to undertake seasonal diverse activities as per the plantation plan for mangrove regeneration in the villages. This is a successful transformation in the village teenage and youth into pro-mangrove action research initiative.

Elderly

The village elderly people were highly keen on action research initiative for village mangrove afforestation. From the inception they were in the planning process of action research initiative. They shared their traditional and indigenous practices which was a value addition. Their experience helped the IGSSS team and the villagers in understanding the history of the natural hazards in the villages for the last couple of decades. Some local elderly experts explained about the number of surviving mangrove varieties, number of mangrove varieties lost, number of surviving mangrove patches and number of mangrove patches diminished in the villages etc. They became the key resources in the villages to guide mangrove rejuvenation research action program. This transformation in village elderly was only due to their inclusion by IGSSS team in the initiative.



Children

Children were the very spontaneous sample groups, physically small but had enormous dreams of mangrove restoration. Since the inception their participation was outstanding. This was due to the painting competition, sports competitions, slogan competition etc on mangrove organized by IGSSS team and the participants and winners were given award for their talent. Some potential children were capacitated with knowledge resources on mangrove. They took leadership in mangrove sensitization and awareness in the villages. These children became the key agents in transforming the perception of villagers into pro-mangrove action research initiative.



Women

Village women played another important role in the action research program for mangrove afforestation in the villages. Most of the women were housewives. Usually, they helped their husbands during harvesting season and worked under the village MGNREGA scheme as per their requirement. The women could manage time to be involved in the action research initiative. They were also an important part in the planning process. Most of the women were skilled in agriculture work. Due to this, they undertook the nursery activities, mangrove seedling preparation, plantation etc. Women also took a significant role in village hazard, vulnerability and capacity mapping process. At the inception, the husbands of most of the village women took decisions for their wives to participate in this action research initiative. But frequent interactions of IGSSS team with the women and their husbands resulted in taking decisions independently by the women. Small incentivization to village women for this action research initiative transformed their role in decision making for both village mangrove restoration and in their family.





Men

At the beginning, most of the village men were very dormant in their participation in action research initiative for mangrove replenishment. This was due to extreme political interference. Due to a few anti-social elements, research action initiative decelerated in the beginning. This was resolved by some village men with steady actions. They became motivated by the IGSSS team, and the action research initiative taken by village youth, children etc and took up steadily. Most of the village men were daily wage labor. They were involved in earthwork, plantation work etc. Small incentivization for their labor contributions made them highly motivated and positive to take mangrove action research initiative in their villages. This was another transformation during the action research process.

Gram panchayat duty bearers and line departments

They were the most eminent people who supported IGSSS team in introducing mangrove action research initiative in the village. They were highly motivated with the plan of action research and supported in plantation, land identification and other administrative processes.

Steps for action research initiative

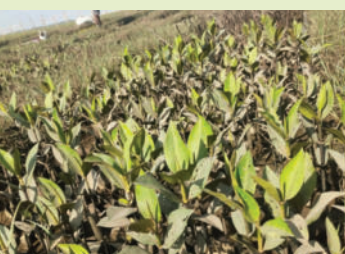


1. Formation of mangrove management committee-

In presence of Gram panchayat duty bearers, a mangrove management committee was formed in each village. The committee had equal number of men and women representations. Youth and the elderly were also part of the committee. Several capacity building training courses were organized for the committee members. This enhanced their confidence and leadership skills in mangrove afforestation.



2. Mangrove plantation site finalization- A total of 10-hectare land in the river estuary adjacent to the villages was identified by the committee and finalized with support from Gram panchayat duty bearers and other line departments.



3. Identification of native mangroves- Through quadrant study, the native species were identified by the youth members of the committee and finalized for plantation in the village river shores. Apart from this, the experience of elderly members of the committee was also considered for species finalization.



4. Spacing of the seedlings & plantation plan- The ideal spacing between the mangrove trees ranges from 10 - 20 meters for favorable growth and survivability. Therefore $10 * 10 = 100$ square meters of spacing was required for quadrant plantation. The field experience conveyed around 33% survivability of mangroves at present due to climate change and other external factors. Based on this experience, the spacing for mangrove seedling plantation in the quadrant was customized to $3 * 3 = 9$ square meters. And in the row plantation in 3 meters intervals. This calculation helped the committee, especially the teenagers and youth members, in estimation of total seedlings required for the plantation in 10-hectare land.



5. Seed collection- In early monsoon (June-July), due to thrust of rainwater droplets, mature seeds fall from the trees and float. The seeds were collected at that time by the committee members. The seeds of the native mangrove species were collected from the neighboring forest patches by youth members of the committee. These collected seeds were used in the nursery for seedling preparation.

6. Nursery activities- A nursery was established adjacent to the plantation site in each village by the women members of the committee. The nursery was comprised of multiple seed beds. It was surrounded by bamboo fencing and a patrolling point was constructed by bamboo at the corner of each nursery. The nursery was taken care of by the local men and women of the committee. The location of the nursery was on the river-shore so that the seedlings could float in river water during hightide. This met the requirement of brackish water for perfect growth of the mangrove seedlings. The nursery activities started at least two months before the seedling plantation.

7. MoU with village administration and community- An MoU was signed between the mangrove management committee and gram panchayat with a specification of role and responsibility of both, the do's and don'ts, punishments if any deviation etc



8. Mangrove plantation- The mangrove plantation was organized into three plantation zones in the river shore. The zones are mentioned below.

a. The first zone was towards the riverside where *Rhizophora* sp. was planted. These trees had prop roots, considered as strongest and most structurally complex root. These roots provided significant stability and support and allowed the trees to withstand strong winds and waves, hence minimized cyclone risk.

b. The second zone was planted just behind the first, closer to the village embankment. This part includes *Avicennia* sp., *Kandelia* sp. etc which have Knee roots, *Pneumatophores* etc, considered as stronger root. This root created a buffer against storm surges and powerful winds. It could also reduce wave energy and helped to attenuate wind energy.

c. The third zone was planted just behind the second, even closer to the village embankment where *Acanthus ilicifolius*, a local mangrove shrub with fibrous roots, was planted. These roots minimized embankment erosion efficiently. Bamboo fencing was given towards the riverside to safeguard the first plantation zone from cyclone and flood till the trees attain maturity. Apart from this, the alternative fodder zone was established in the interior part of village which minimized the risk of livestock overgrazing in the mangrove zone. Men and women members from mangrove management committee took leading role in mangrove plantation.





9. Patrolling & documentation - Some men members of the committee were given responsibility for patrolling the mangrove plantations. They undertook this responsibility very sincerely and detected few animal grazing cases in the mangrove plantation zone.

10. Measurement of health and survivability of mangrove plantation & documentation -

The youth and teenagers from mangrove management committee started the measurement process of mangrove plantations. They were imparted training in measurement of the height, girth and crown cover of the plantations. They documented the mangrove measurement data for research in the forthcoming days.

Strategy for action research initiatives

1. Consensus on pro-mangrove initiative- Priority of IGSSS team was to develop basic understanding on mangrove and capacity building within the sample groups so that the proactive persons from the sample groups could take lead in action research initiative. Quality training modules and tools were used by skilled facilitators for capacity building. Apart from this, exposure visits to the field of peer organization were organized. These enhanced the confidence and helped the sample groups bring a consensus on pro-mangrove initiative in the villages.

2. Research on in-situ social forestry- An in-situ (native) social forestry model was conceptualized by IGSSS team with the village elderly sample groups who had traditional knowledge and experience. This in-situ social forestry model extended to the nature-based solutions in the long run through conservation of mangrove ecology and simultaneously safeguarding the coastal villages from cyclone and floods. In addition, this model can address the air emission through carbon sequestration process in future. Participatory management and protection of surviving mangrove forest patches, control over deforestation, amplifying mangrove forest patches etc were the value addition to the in-situ (native) social forestry model through this action research initiative. Below were the commitments by the sample groups in mangrove action research initiative,

a. The sample groups organized regular patrolling to the plantation patches till the mangrove trees attained maturity. This could minimize the risk of



grazing. They also organized patrolling of the surviving mangrove forest patches to check the illicit felling.

b.The risk of grazing was minimized by fencing to the mangrove plantation patches with the thorny weeds (*Acanthus ilicifolius*) or any natural means.

c.The sample groups organized weeding in the mangrove nurseries. They excavated traditional water irrigation structures close to the mangrove plantation patches. This helped the plantation patch access river water even in the low tide period.

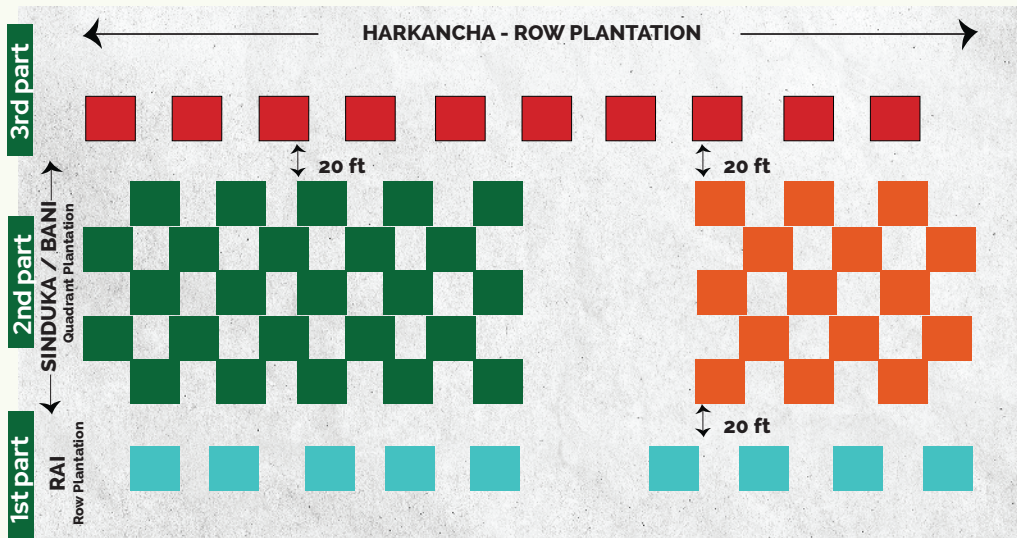
d.They built mangrove nurseries in-situ (local) which multiplied the possibilities of mangrove regeneration and minimized the risk of loss of the mangrove seedlings by refilling.

e.A quadrant study in the neighboring forest patch was undertaken to identify the native mangrove varieties. This helped in mangrove species finalization for plantation. It reduced the risk of loss in mangrove plantation.

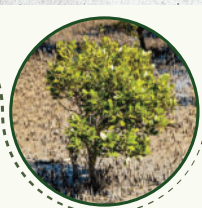
3. Monitoring health quality of mangrove plantation- The youth sample groups were imparted training on monitoring the health quality of mangroves planted during this action research initiative. The growth in the height and girth of the planted seedlings were measured quarterly in a year. The data were collected from the field and maintained in a data inventory or register by the youth for future reference.

4. Linkage, networking and visibility- Liaison with the departments and duty bearers could be a value addition to upscale and replication of the action research model. Networking with the peer organization, experts, influential persons etc helped in dissemination, visibility of the action research model. Coalitions with the existing mangrove alliances (national and international) was an opportunity for the village youth sample group to enhance their knowledge and understanding. Tagging with the mangrove alliances in social media also increased the visibility





1st part
Rhizophora

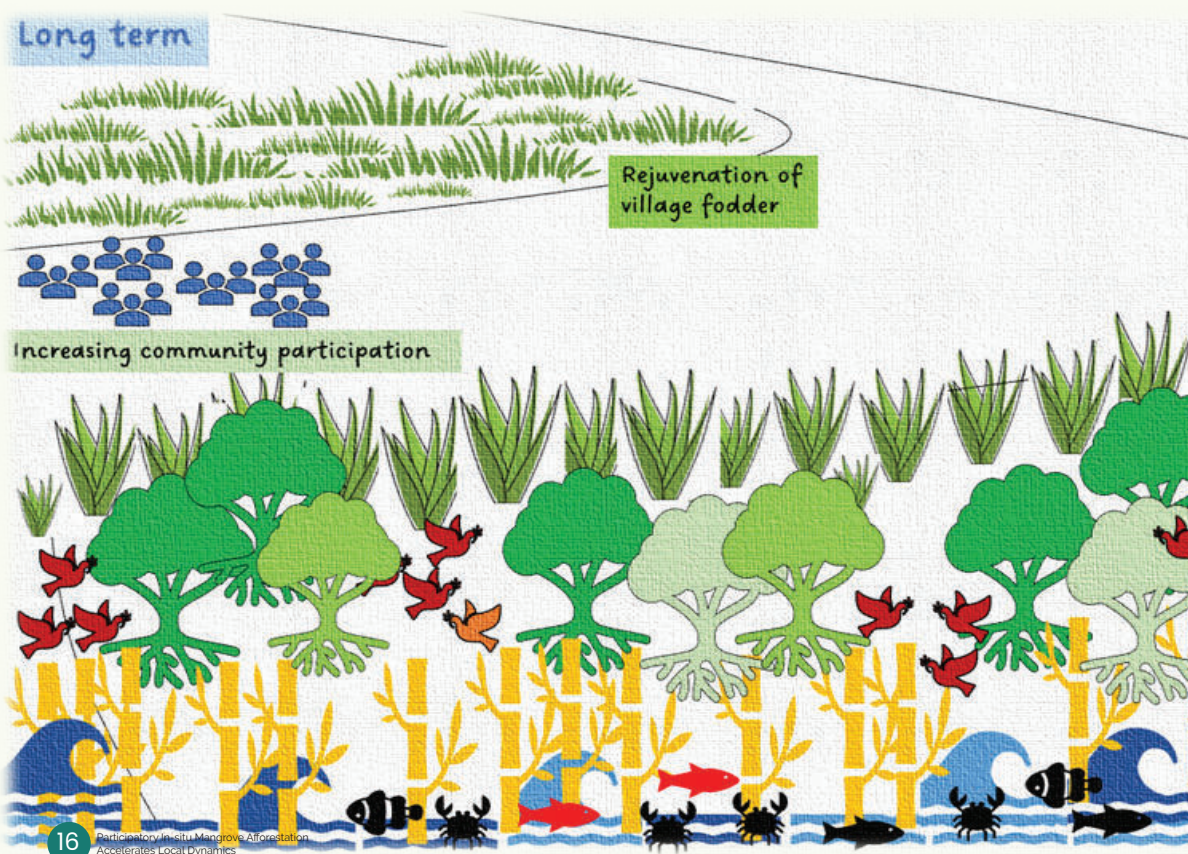


2nd part
Avicennia



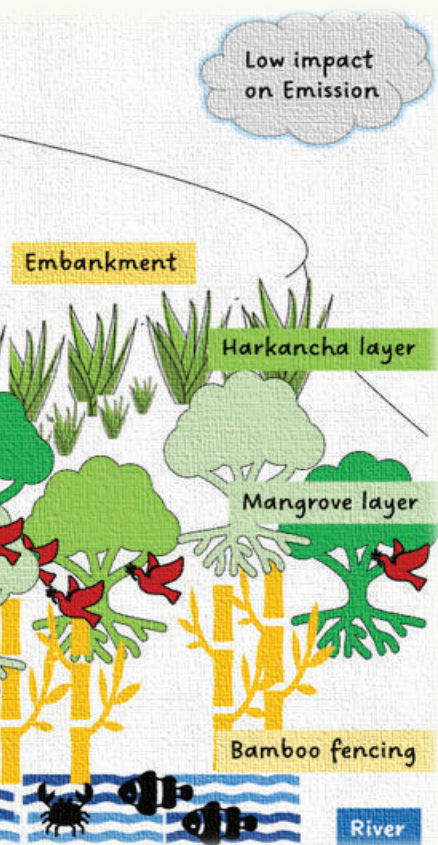
3rd part
Acanthus ilicifolius

Long term



Gains from action research initiative

- a. A bonding between the mangrove and the sample groups of the villages became highly visible.
- b. The level of knowledge on mangrove and confidence in the village youth and teenagers increased. As a result, they led the action research initiative for mangrove afforestation in village.
- c. Restoration of village coastal mangrove ecology happened through in-situ (native) conservation and management of mangrove. Around 27 thousand mangrove seedlings were planted in ten-hectare river shore in the two villages, out of which 50% survived, most of them attained 1 meter or more height.
- d. Village children sample groups mandated mangrove sensitization and awareness in their school and village hamlet.
- e. Native mangrove seeds were collected from the neighbouring forest patches and cultured in the two nurseries established in village river shores. The nurseries were the key centres to multiply the number of mangrove varieties, hence value addition in coastal mangrove ecology.
- f. Women became technically sound in mangrove culture. Their knowledge level and confidence enhanced. Small incentivization from this action research initiative gave them space in the decision making of their family.



Participation in global mitigation measures

The action research initiative led to a positive change in knowledge, attitude and practice of the village sample groups to undertake pro-mangrove initiatives. Apart from safeguarding the coastal villages from flood and cyclone, mangrove afforestation can minimize substantial quantity of carbon- dioxide from atmosphere, approximately 5 lakh quintals in the next three years. This mangrove afforestation can address air emission and can be considered as a part of global mitigation measures in the long run.

Reference (as on June 2025)

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Author: Dr. Shisir Kumar Das

a professor turned social scientist and development practitioner has contributed immensely to the global pool of knowledge in varied domains ranging from ECD, inclusive education, disability, tribal issues, governance, youth development, climate change, disaster management, gender, energy and community media etc. Being an ardent advocate of inclusive and participatory development he has engaged himself with communities

for more than thirty years. As founder Director of Indian Institute of Education and Care (IIEC) based in Odisha, he has achieved a number of significant milestones at the national as well as international level. Being a strong believer in networking he is leading a number of networks and forums based on issues and human rights. Dr Das is, now a days, into mentoring and grooming future social leaders to spearhead the movement of inclusion and social justice. Known for innovation and research, he has added values to so many initiatives in different sectors. Primarily committed to human resource development, he has been a change agent in people's lives and community dynamics. He has remained dedicated to his soil and soul in spite of rich exposure to so many foreign countries. He is now heading an international initiative on urban climate change and also exploring frontiers of knowledge as to how mangroves with the power of community can combat climate change. He has authored some spectacular books and papers on Inclusive education, learning disability, urban governance, disaster dynamics, climate change and community media. Dr Das has already bagged so many state and national awards for his lifetime achievement in social sector. Besides his development milestones, he is also known for his creative and critical writing in both Odia and English ranging from poetry and plays to story writing.



Author: Proshin Ghosh

With over twenty years of experience, Proshin is a result-oriented community development practitioner addressing climate change crises in vulnerable communities. He believes in the demystification of climate change science to the niche community, strengthening them to identify climate change risks and coping mechanisms or resiliency for encountering climate crisis. He passed Post Graduation in Botany & Forestry and Management in Environment

Management. Since last ten years, he is leading Indo-Global Social Service Society (IGSSS) for incentivizing climate and environment, and conservation of natural resources, through undertaking several actions.

He is a mangrove learner, has eminent working experience in Sunderbans with European Commission under DIP-ECHO programs. He is the pioneer in IGSSS, introducing 'Community led Mangrove Restoration' in Astaranga, Puri, Odisha under the lens of nature-based solution in collaboration with DIAGEO.

The Climate Change Matrix tool, Climate-Gender Matrix tool reveals outstanding community engagement with climate and environment, which is his creation only. He conceptualized and piloted Urban Disaster Risk Reduction (UDRR), Urban Farming and Heat Wave Resilient Houses models in the urban settlements.