The Nature Conservancy
India

GUIDE FOR RESTORATION OF RIPARIAN ZONES OF NARMADA RIVER AND ITS TRIBUTARIES.



Grateful To

1. Divisional Commissioner, Narmadapuram
2. District Collector, Narmadapuram
3. Chief Executive Officer, Zila Panchayat Narmadapuram
4. Gram Panchayat Representative, District Narmadapuram
5. People of Narmadapuram District

Special Contribution

1. Jan Abhiyan Parishad
2. Indian Grameen Services

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Disclaimer: This guide describes a systematic approach for restoring the riparian zones of the Narmada River and its tributaries. The information presented in this guide combines scientific best practices with indigenous knowledge. It serves as a framework for grassroots-level stakeholders and should be customized to suit specific local conditions, rather than considered a one-size-fits-all solution for optimal outcomes. While this guide is applicable to riparian zones along the entire Narmada Valley, it is particularly well-suited for the specific needs of the Narmadapuram division.

Guide for Restoration of Riparian Zones of Narmada River and its Tributaries.

About The Nature Conservancy (TNC)

The Nature Conservancy is the largest conservation organization in the world working to protect the lands and waters on which all life depends. Founded in 1951, TNC addresses environmental challenges in more than 76 countries and territories through a scientific and nature-based approach.

We have been engaged in environmental and developmental initiatives within India, focusing on nature-based solutions. These endeavours involve close coordination with the Indian government, research institutions, private sector entities, non-governmental organizations, and local communities. Our primary objective is to align with the Government of India's national priorities, leveraging our scientific acumen, extensive global experience, capacity to scale projects from pilot phases to broader implementation, and proficiency in proficiency in collaborating with relevant stakeholders.

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INTRODUCTION

About River Narmada

Since ancient times, rivers have been pillars of human civilisation by contributing to our economic and cultural development. For central India, particularly for the state of Madhya Pradesh, the River Narmada is a lifeline. India's fifth largest river, it is also the state's critical source of water for drinking, irrigation and hydropower.

The literal meaning of Narmada in Sanskrit is 'Giver of Pleasure' and the river is also known as Rewa (which means playful) in mythological and folk literature. It is considered a sacred river and millions of people derive spiritual enrichment by visiting several religious places along its course.

The river forms a traditional boundary between the northern and southern parts of India. Originating at the meeting point of the Vindhya and Satpura mountain ranges, on the crest of the Amarkantak (1057 meters above mean sea level), it runs a picturesque course to meet the Arabian Sea at the Gulf of Khambhat (Cambay), 10 km north of Bharuch in the state of Gujarat. The river has 19 major tributaries – Hiran, Tendoni, Barna, Kolar, Yaar, Uri, Hatni, Orsang, Burhner, Banjar, Sher, Shakkar, Dudhi, Tawa, Ganjal, Chhota Tawa, Kundi, Goi and Karjan.

The basin area of the Narmada is about 99,000 sq km, 89% of which lies in the state of Madhya Pradesh. About 57% of the basin area is under agriculture, 33% under forests and roughly 6% of the area is classified as wasteland. Water bodies occupy roughly 3% of the basin area and the remaining 1% is built-up land across rural and urban areas. In the upper reaches of the basin, the forests are of tropical, moist, deciduous type, whereas in the middle and lower basins, the vegetation is of tropical dry and deciduous type. The river basin includes some of India's most biodiverse landscapes including the Kanha Tiger Reserve and Panchmarhi Biosphere Reserve. The river basin is home to more than 4,000 flora, 276 birds, 76 mammals, 50 snakes, 150 butterflies and 118 fish species. The state fish of Madhya Pradesh – the Mahseer - is endangered and thrives in several stretches of the river.

Namami Devi Narmade

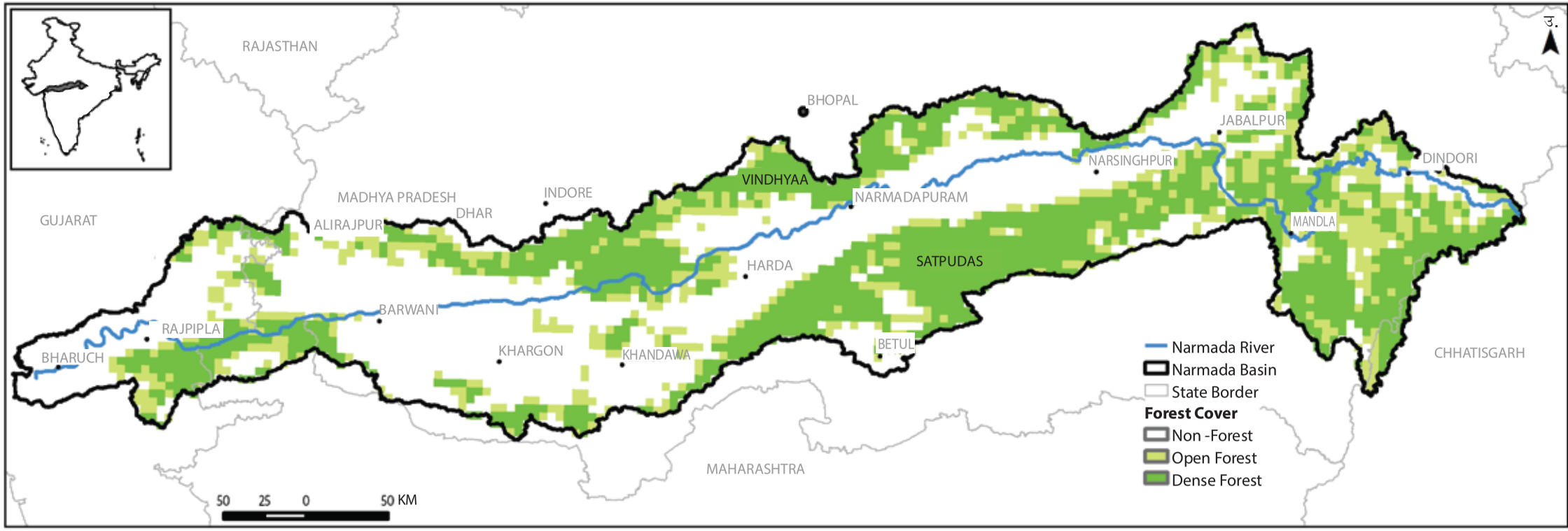
While the water quality of the Narmada can still be considered better than most large Indian rivers, the forest-fed river is facing intensive threats due to anthropogenic pressures and climate change. These threats include deforestation, increasing urbanization, unsustainable and unsustainable sand mining, domestic, agricultural and industrial waste water flows, and the spread of invasive species. Human interference in ecosystems is causing problems and climate change for the entire earth.

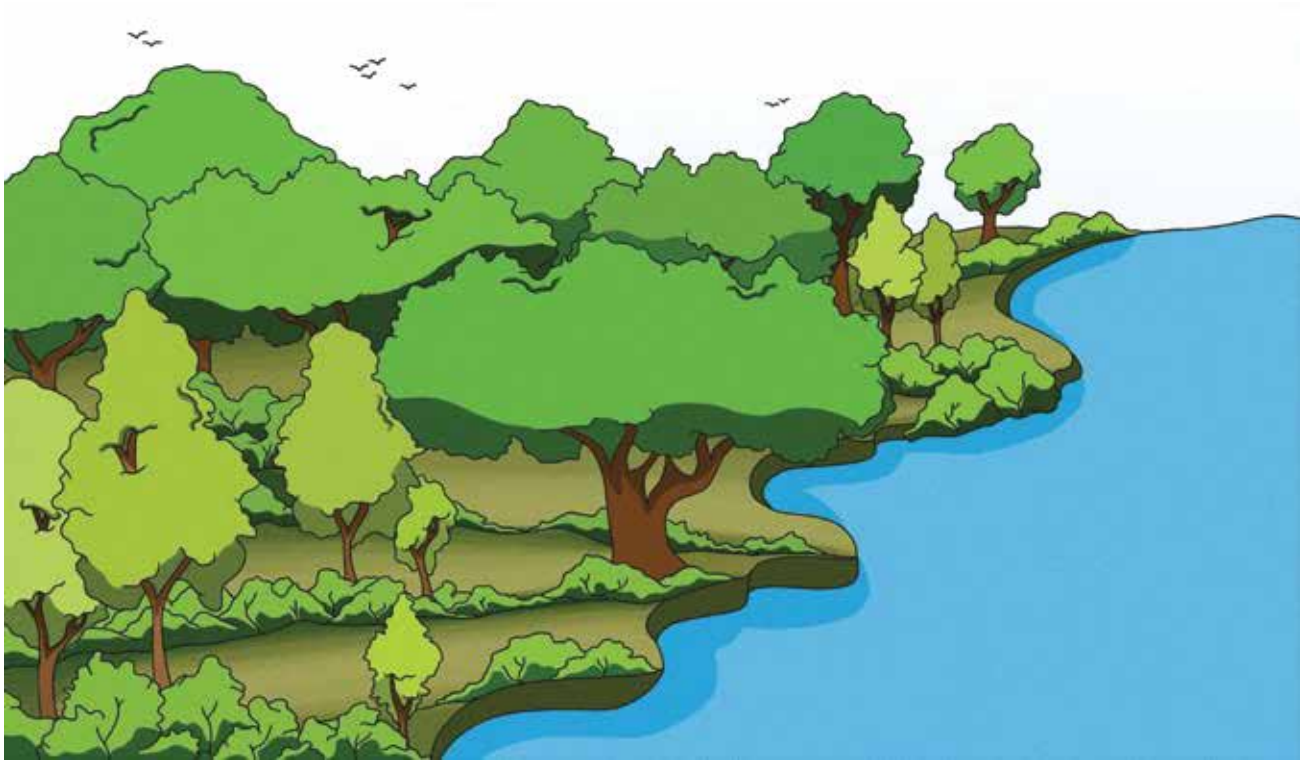
In an effort to mitigate the effects of human activities and climate change on the Narmada River while emphasizing the paramount importance of river conservation, the Government of Madhya Pradesh introduced a groundbreaking public initiative known as 'Namami Devi Narmade' in 2016. 'Namami Devi Narmade' served as the cornerstone for energizing the rejuvenation of the compromised riparian zones along the Narmada River and its tributaries. The primary goal is to safeguard the riverbanks, curbing soil erosion, with the ultimate aim of preserving the eternal purity of river Narmada.

Narmada Pavitra Sarvada

To support the state level initiative 'Namami Devi Narmade', Narmadapuram division has focused its efforts on restoring riparian areas. This program named 'Narmada Pavitra Sarvada' is being implemented by Jan Abhiyan Parishad in Narmadapuram and Harda districts.

NARMADA BASIN





RIPARIAN ZONES

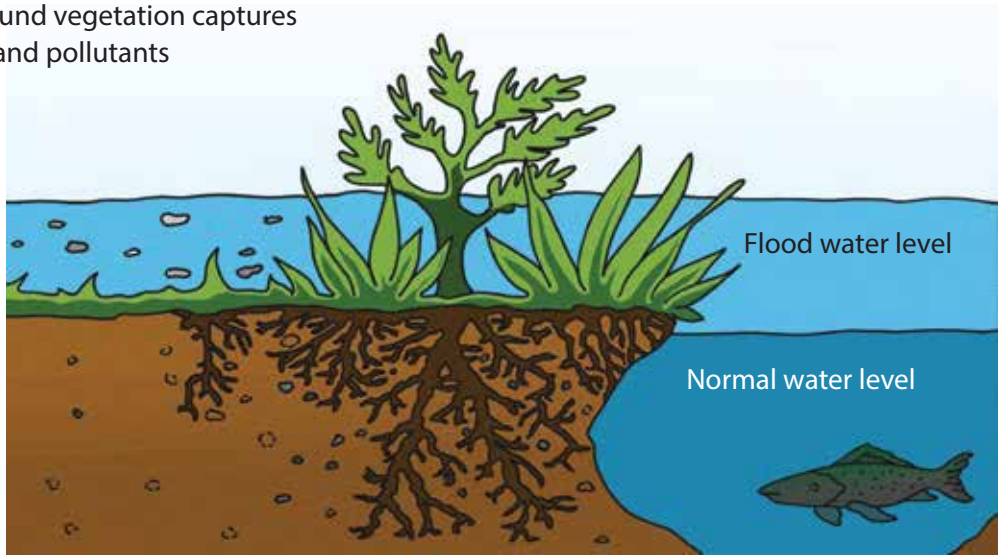
Riparian zones, also known as riparian habitats, can be described as areas with varying degrees of vegetation located alongside rivers and streams. These zones encompass streams, wetlands, and riverbanks. The specific width of a riparian zone is determined by a range of factors, including the flow of the river, topography, climate, and more. Generally, a riparian zone is scientifically recognized to extend approximately 50-100 meters on either side of a river and its major tributaries. However, smaller tributaries and streams may have narrower riparian zones.

Healthy riparian zones are essential for upholding the ecosystem equilibrium, as they offer crucial ecosystem services and occupy a significant position within the local environment.

riparian zones serve both human and natural environments in the following capacities:

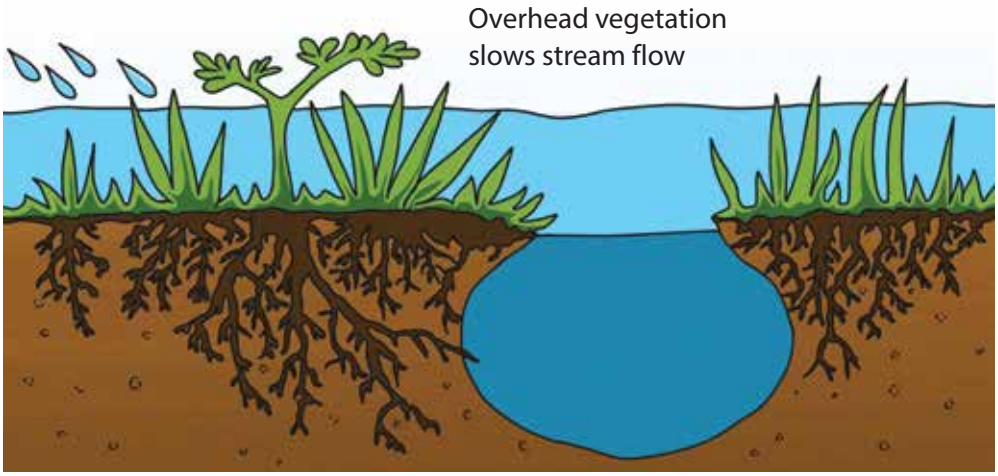
- Mitigate the spread of flood surges by stabilizing the river bank.
- Reduce flood damage by storing and slowly releasing flood waters.
- Reduce erosion by slowing the flow of water and binding the soil.
- Reduce and prevent water, soil and air pollution.
- Recharge and discharge groundwater .
- Provide food and niche habitat for biodiversity on land, water and air.
- Capture carbon and mitigate the consequences of climate change.
- Protect the natural process of pollination and natural pest management.
- Provide natural crops and medicinal herbs.
- Provide opportunities for recreation, tourism and spiritual enrichment.
- Act as corridors and refugia for wildlife.

Above ground vegetation captures sediment and pollutants

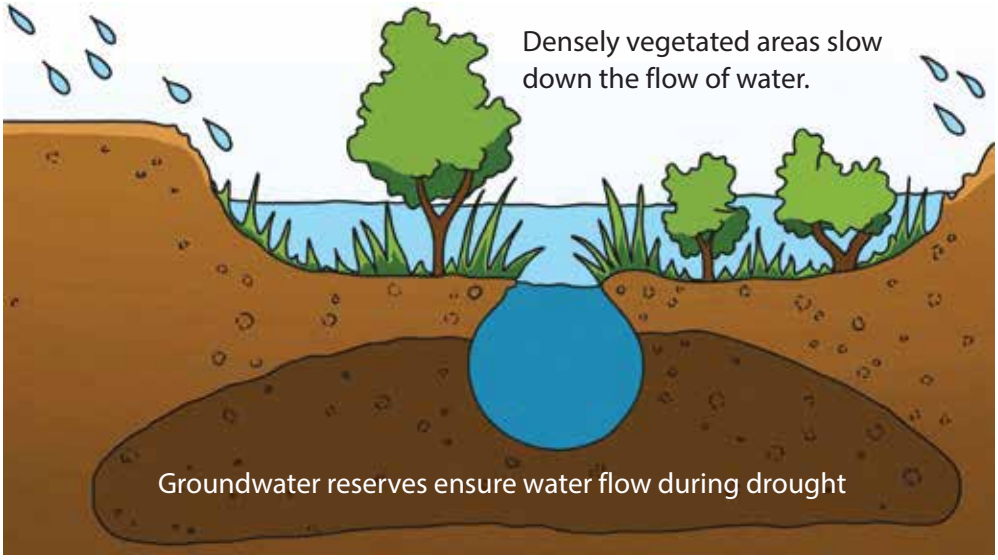


The root system traps fertilizer and pesticide residues.

Reduces run off, pesticides' and insecticides' residue; making habitat conducive for flora and fauna



Deep roots hold the soil in place at the edges, reducing erosion



The soil absorbs rainwater to create groundwater reserves.

Rationale behind this guide

Narmada River is the lifeline of Central India. Flowing for centuries, River Narmada not only provides water, food, and a means of living but also plays a pivotal role in maintaining ecological equilibrium. The economic, social, and spiritual significance of the Narmada is unparalleled, making it an inseparable component of our culture.

Human activities have continued to deplete and exploit the Narmada River for their own benefits. Consequently, on one side, its water flow has diminished, while on the other, the surrounding forests and soil have suffered damage. This has resulted in a decrease in the populations of various animal species, vibrant butterfly communities, the melodious calls of diverse birds, a variety of insects, bees, and aquatic life that used to inhabit the habitats around Narmada River vicinity. The populations of Mahaseer fish and other indigenous fish species in the Narmada River are declining. It is imperative to implement effective measures to ensure the perpetual cleanliness of the life-sustaining Narmada River and its tributaries while also conserving the biodiversity dependent on these habitats.

Under the state level program 'Namami Devi Narmade', Narmadapuram division has initiated the 'Narmada Pavitra Sarvada' campaign. Through this campaign, all the stakeholders of Narmadapuram division are committed for the protection, conservation and management of the riparian zones of Narmada River.

In order to mitigate the damage caused by erosion, the ongoing reduction in water flow and sudden floods along the riverbanks, tree planting and its maintenance are being carried out in every village.

The efforts being made by the government and public participation are commendable, but it is necessary to include scientific principles in these efforts to strengthen the ecosystem of River Narmada and to protect it from future degradation. The objective of this guide is to ensure that the ongoing initiatives within riparian zones are both sustainable and aligned with the natural ecosystem.

This guide can be utilized to enhance the implementation and coordination among the rural population, government personnel, officials, and supporting organizations involved in the restoration efforts in the Narmada riparian zone.

This guide offers a convenient collection of 60 native plant species and instructions on planting them. To identify these species, an extensive community survey was carried out in villages located along the Narmada River's banks.

The aim of this guide is to elucidate the timing, methods, and locations for planting riparian plants, along with strategies for safeguarding and managing them. The information contained in this guide is essential for the restoration of degraded riparian vegetation zones.



PROTECTION, CONSERVATION AND MANAGEMENT OF RIPARIAN ZONES

To develop healthy riparian zones at the ground level, it is very important to follow certain parameters. All members associated with the restoration work should follow these for safety, conservation and management so that the restoration goal can be achieved.

1. Community Participation



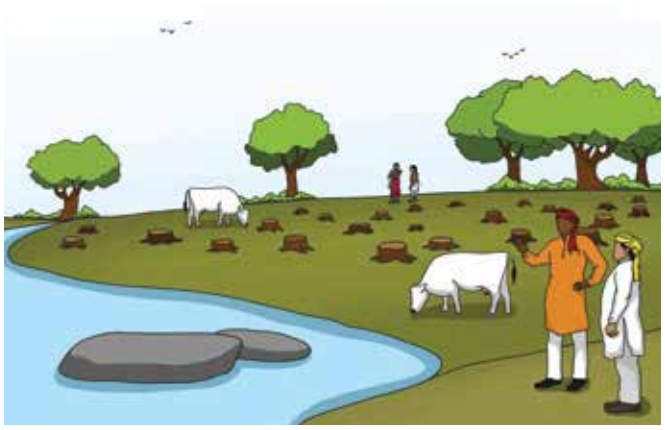
Many people in the villages situated on the banks of River Narmada are self-motivated and committed to the conservation of this holy river and are serving selflessly. Along with such persons, women's groups, teachers and other eminent citizens can meet at the village level and establish coordination through mutual discussion and form a coordination committee. These can be revived in villages where there is a Prasfutan Committee formed by the Jan Abhiyan Parishad.

To increase this coordination at the village level, an action plan for the protection, conservation and management of riparian zones can be made with the community cooperation of Sarpanch, Secretary, Employment Assistant, Mate, Kotwar and other Panchayat representatives.

The involvement of society, government, and NGOs is crucial for successful conservation work.

This not only establishes an environment for conservation efforts but also offers direction for plan execution. Partnerships form the basis of mutual trust and robust relationships, fostering collaboration between departments, coordination with MNREGA, and other governmental and non-governmental initiatives and resources.

2. Selection of riparian area and restoration principle



The need for restoration of various types of damaged riparian zones and their conservation aims at a series of actions that can be initiated and implemented in a phased manner. Some indicators of damaged riparian zones are:

- Loss of original ecological integrity and regenerative capacity.
- Emergence of areas affected by landslides and wastelands due to floods and other extreme weather events.
- Vegetation cover reduced to 0-40%, or conversion to agriculture.
- Erosion of soil and vegetation in sandy areas.
- Loss of native species due to unintentional spread of invasive species.

The village level coordination committee, general public and Panchayat representatives can travel together and select the damaged riparian area using these indicators. After selecting the riparian area, which restoration principle will be applied to that area has to be selected.

Riparian conservation is the repair or restoration of ecosystems that have been altered by human intervention and climate change. It emphasizes on restoring the original structure of local biodiversity and the resulting ecosystem.

Conservation of riparian zones works on two principles-

REHABILITATION

Rehabilitation is an effective strategy for restoring the ecological structure and regenerative capacity of degraded riparian zones, as well as addressing issues like soil erosion and wetland conversion. It involves planting and managing dense native vegetation to revive the area's original ecological balance. This principle can also be applied to riparian zones where tree cover is about 0–20 percent, or which were previously cultivated.



REGENERATION

On the other hand, regeneration works for riparian areas that have intact their original ecological structure but are losing their capacity to regenerate. However, the regeneration capacity is diminishing. Typically, these riparian areas have tree cover ranging from 20% to 40%, and people utilize these trees for conservation and wood storage. Signs of initial soil erosion, like gully formation and old tree root systems, are becoming noticeable. In these onshore areas, security is a top priority and management is often in the hands of indigenous businesses.

Note: For some riparian areas, both the principles of rehabilitation or regeneration can be applied.

After selection of the riparian area and restoration principle, the coordination committee can place it as a proposal in the Gram Sabha. The consent of the Gram Sabha is important to ensure smooth coordination for protection, conservation and management of riparian zones and to avoid any disagreement among the village or community members.

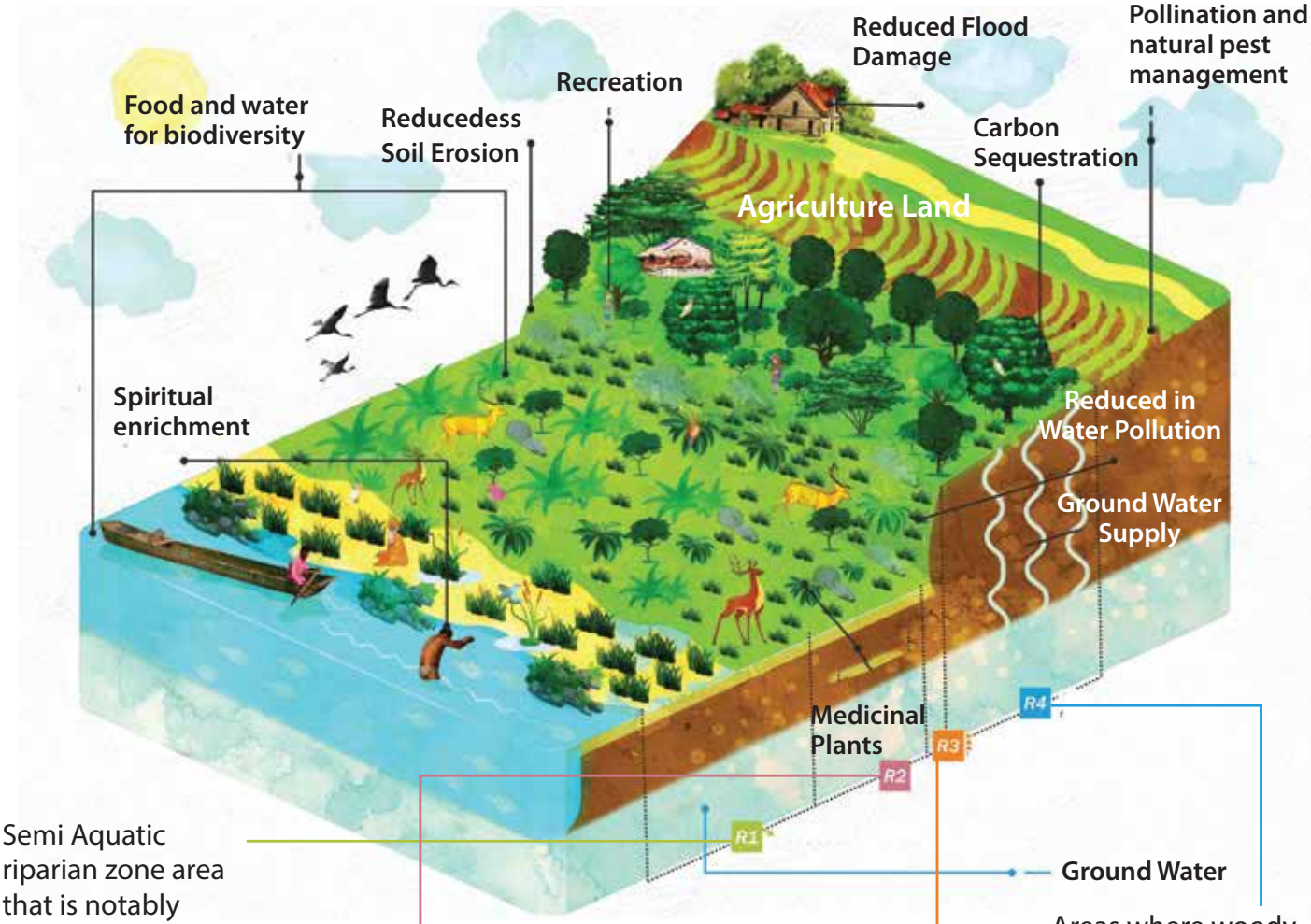
3. Classification and measurement of riparian zones

Classification and measurement of riparian zones is a crucial initial stage in the planning of restoration efforts, and it can be structured as follows.

CLASSIFICATION

From the scientific point of view, there are different views about classifying the riparian zone into three or four sub-categories. In this guide, we have classified these into four sub-categories based on location, soil characteristics and vegetation – R1 R2 R3 and R4, with R1 being closest to the river (See image on page 14).

CLASSIFICATION OF RIPARIAN ZONE



Semi Aquatic riparian zone area that is notably abundant in aquatic species like aquatic herbs, shrubs, and grasses.

Areas that are predominantly flood plains/sandy areas are dominated by semi-aquatic plants including herbs, shrubs, vines, creepers, and grasses.

This is an area with steep slopes, where there is an abundance of terrestrial vegetation including herbs, shrubs, creepers, vines, and grasses.

Areas where woody vegetation including trees, herbs, bushes, creepers, vines and grass is more available.

R1

R1 is the area, which would get flooded for a few days during wet season. This area helps protect the river-bank and provides habitat for aquatic life. Aquatic grasses, herbs and shrubs are characteristic vegetation of this area.

R2

R2 is the area beginning from where R1 ends till steeply sloped lands along the riverbank. It is generally part of the floodplain. This area helps in the maintenance of water quality and supports wildlife. Terrestrial grasses, perennial herbs, climbers, shrubs and few trees are characteristic vegetation of this area.

R3

R3 is the area consisting of steeply sloped lands, which are also part of the floodplain. This is generally seen to have high soil erosion and thus grasses, herbs, shrubs and trees that help bind soil and reduce erosion are characteristic vegetation of this area.

R4

R4 is the outer area of the river-bank after steep-sloped lands and supports more woody vegetation like trees and shrubs. It helps to trap sediments, filters pollutants and provides a habitat for various fauna.

The village level coordination committee, community members and Panchayat representatives can visit the selected riparian area and classify the riparian area using these indicators. Apart from this, looking at the local situation, the land can also be categorized on the basis of size and type like sloping land, flat land, sandy land etc.

After classification, the next process is to measure the area of each class. It is important to ensure that the area of each category is calculated correctly. This is because all aspects related to implementation like requirement of plants and labor, other planting material, irrigation system, safety and management plan etc. will be based on the area under each category.

Note: Due to less vegetation and easy access, the best time for classification and area measurement is during the months of March-April. It would be better to select the riparian area and measure the area under each category with the support of the local Patwari, because through the ETSM machine, demarcation of the entire area and area of the category can be done accurately. Land can be measured in acres.

4. Reference riparian area and target setting

Reference riparian area is that area on the basis of which a comparative study of the selected site is done. It manifests itself in the same locality or similar geographical and environmental conditions. Nearby protected forest areas, such as the riparian habitat of the Satpura Tiger Reserve, can be considered as reference sites. Altitude, rainfall, soil type and plant communities should be similar in the selected reference site.

In addition to this, the riparian habitats being conserved under the 'Narmada Pavitra Sarvada' campaign, like Ajera (Sohagpur) and Dhansi (Makhan Nagar), can be visited for an exposure visit.

Considering a healthy riparian habitat, from context of the village, the Gram Sabha (Village General Assembly) and the coordination committee can do proper target setting and make action plans for protection, conservation and management of concerned riparian areas.

5. Conservation and Restoration Action Plan

The conservation and restoration action plan will depend primarily on the identified restoration principles (page 13). If the applicable principle is regeneration, then priority should be given to protecting the riparian zone and selectively planting and managing native vegetation. If the applicable principle is rehabilitation then the riparian zone should be planted and managed with dense native vegetation. Both principles may also apply to some riparian areas.

The village level coordination committee, community members and Panchayat representatives can come together and formulate an action plan to start conservation and restoration implementation. After developing it, village level stakeholders can start the work with the support of social organizations like District Administration, Jan Abhiyan Parishad and TNC. Following are the main components of the action plan:

5.1 PROTECTION PARAMETERS

The protection of the riparian zone necessitates safeguarding it against potential hazards like cattle grazing, wildfires, deforestation, and invasive weed infestations. To achieve this, the coordination committee may engage in collaborative efforts to establish specific conservation guidelines. These guidelines could include designating certain areas as off-limits to grazing and timber harvesting, permitting the collection of only dry wood, and implementing a "cut and carry" system for fodder.



The Gram Sabha has the authority to designate restoration champions or restoration champions through MNREGA for the enforcement of these criteria and for carrying out additional conservation tasks. As per administrative guidelines, one restoration champion can be designated for every 2.5 acres of land. Given the unique nature of each selected riparian area, the Gram Sabha is encouraged to create its own guidelines in collaboration with the coordination committee. It must be ensured, though, that the number of workdays for a restoration champions does not exceed 100 days.

Note: List of some preliminary tasks of the restoration champion is given in Annexure 2.

5.2 ASSESSMENT AND ERADICATION OF INVASIVE AND ALIEN SPECIES AFTER APPLYING PROTECTION CRITERIA

After implementing protection criteria, assessment and eradication of invasive and alien species is the next step. If invasive and alien species are found in a selected riparian area where they weren't present before, then these species become harmful to the ecosystem of the riparian area. These species spread rapidly, competing with and replacing native species. These species have harmful effects on natural ecological processes, such as changes in soil quality, changes in vegetation structure and reduction in diversity. We can get rid of them in the following way:

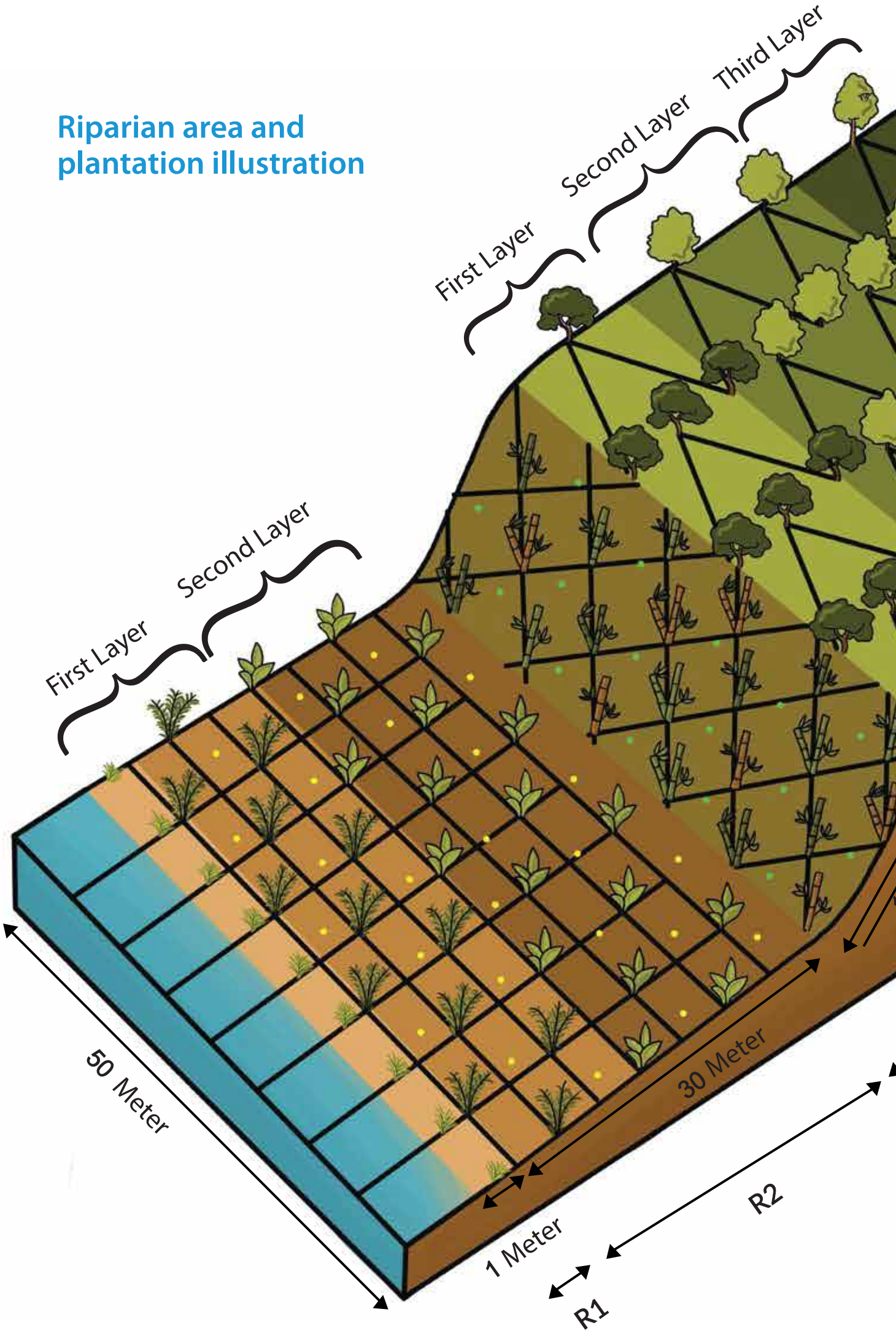
- First of all, uproot them completely by hand or any small agricultural equipment.
- Collect all the uprooted plants and leave them to dry in a big pit.
- Burn dry plants in a controlled manner. Please ensure that the fire does not spread.

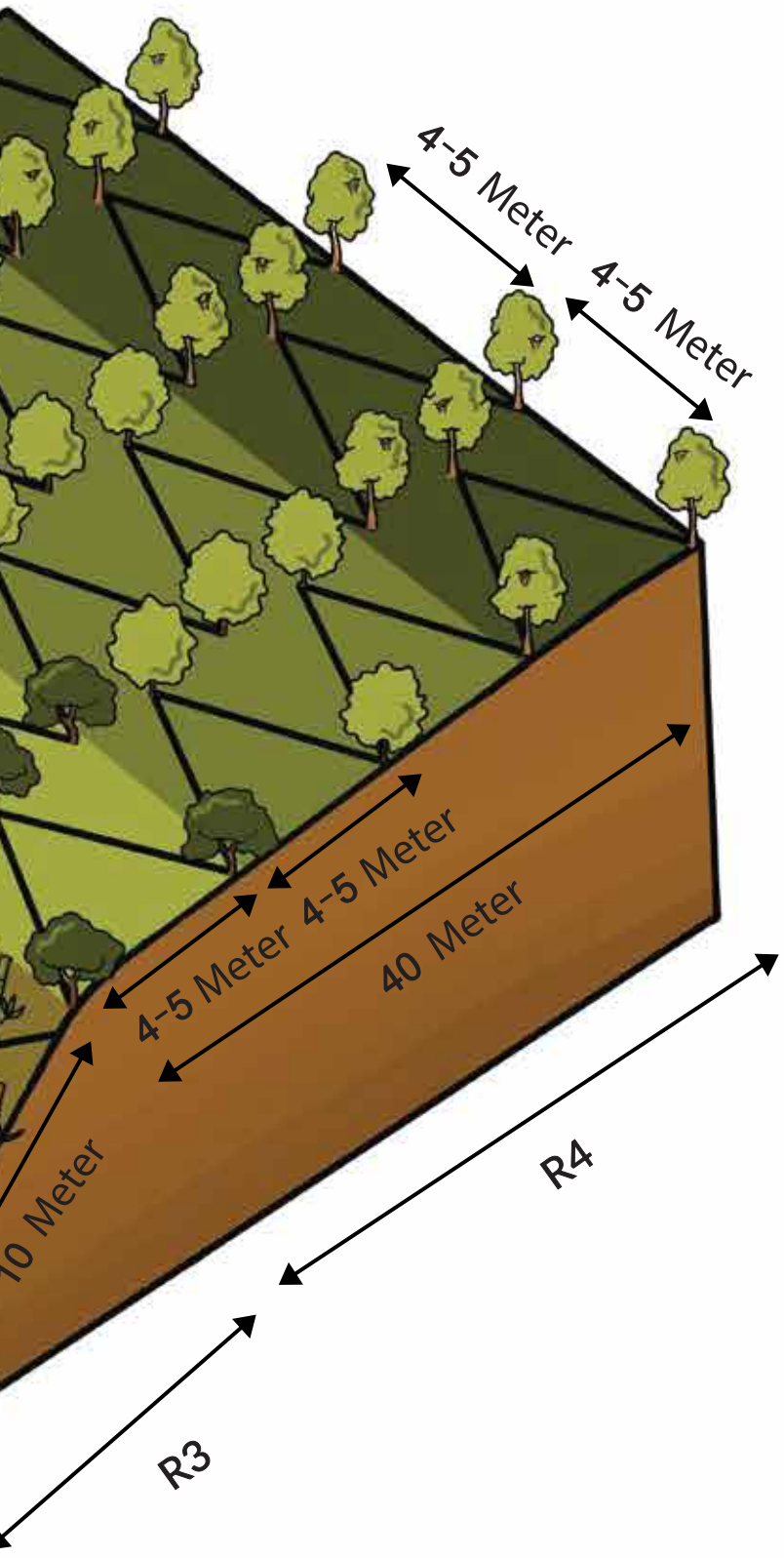
Note: The best time for eradication is after a couple of spells of rain as the soil is moist and it is easier to uproot them.

It is challenging to completely eradicate invasive and alien weeds, but it can be achieved through half-yearly removal efforts. A comprehensive list of locally discovered alien species can be found in Annexure 3.

Note: Herbicides or pesticides should not be used to kill weeds, as these can be harmful to the soil, animals, birds and native plants.

Riparian area and plantation illustration





Trees to be planted on the third layer of R4

Trees to be planted on the second layer of R4

Trees to be planted on the first layer of R4

Bamboos Trees to be planted on R3

Trees to be planted on the second layer of R2

Trees to be planted on the first layer of R2

Plants propagation on R1

Ankol Seed propagation on R3

Propagation of Vetiver grass or other grass seeds on R2

* Specific information regarding the plantation process for each zone - R1, R2, R3, and R4 is provided in the following sections.
Refer to Annexure 4 in the Guide for a comprehensive list of plants.

5.3 RESTORATION METHOD ACCORDING TO CLASSIFICATION

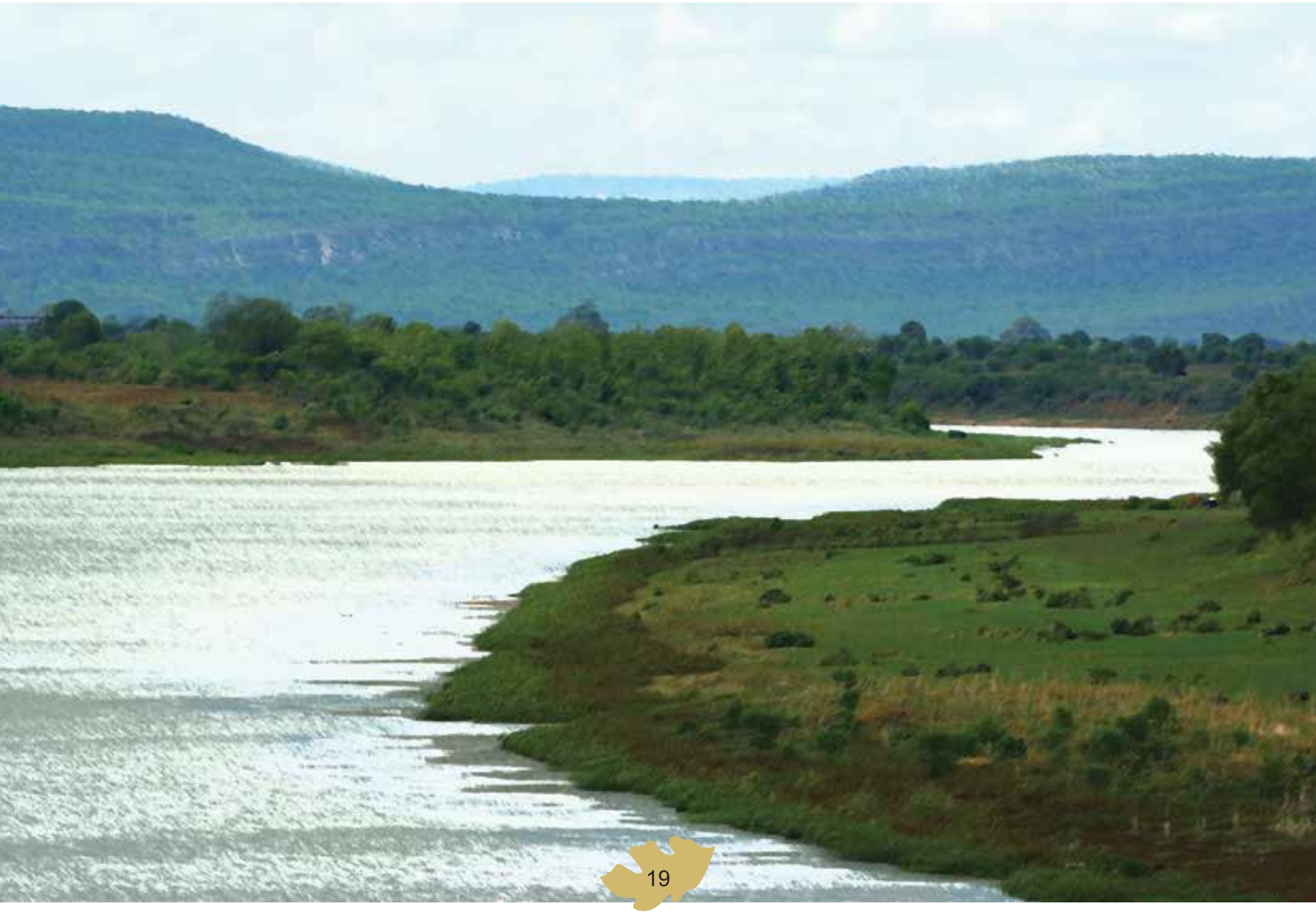
The classification of specified riparian areas (R1, R2, R3, and R4) and measurements can be found in full detail on Page No. 15.

Selection of Restoration process and its implementation is an important and technical step. Therefore, to enhance comprehension and facilitate adoption, a customized model for each category is presented on the next page of this guide.

In the model, we have portrayed a riparian area encompassing 1 acre or 4,050 square meters. This illustration includes all four segments of the riparian zone, with a combined length of 81 meters and a total width of 50 meters.

Category Illustration	Length (Meter)	Width (Meter)	Area (Square meter)
R 1	1	50	50
R 2	30	50	1,500
R 3	10	50	500
R 4	40	50	2,000
Total	81	50	4,050

Note: The illustration given on page 18 is for demonstration purposes, the riparian areas selected may vary in length and width. It is also possible that the chosen riparian area may not have all the categories but may include only two or three. If the selected riparian area already boasts vegetation cover, the proposed restoration approach can be implemented in the available open spaces. Stakeholders will need to tailor their action plans according to the specific classification, measurements, and the open spaces available within the selected riparian area.



Based on this illustration, the recovery method should be chosen and executed as follows –

5.3.1 R1

Category Illustration	Length (Meter)	Width (Meter)	Area (Square meter)
R 1	1	50	50

R1 is a thin strip of land adjacent to the river channel, in which mainly aquatic plants grow. In the illustration the R1 category is 1 meter in length and 50 meters in width. R1 is under water or remains wet almost throughout the year, although it is dry only during peak summer. For this reason, protecting this coastal range is the most effective way to reinstatement or restoration of this area.

However, effective results can also be obtained from vegetative propagation. Local herbs like Patera, Vacha, and other native aquatic flora can be propagated to help stabilize the soil.

R1 Herbs Propagation Process

1. Prepare R1 for planting, eradicate invasive species (June) and mark the planting area.
2. Identify the location with a rich abundance of Patera, Vacha, and various other native aquatic plant species. Give priority to nearby areas to collect these species.
3. Uproot these species, including their roots and surrounding soil (September / October). Collect the uprooted vegetation, which measures at least 10-12 inches in length, and place it securely in a tray before transporting it to the chosen destination.
4. Plant them at least 2-3 inches deep in moist or marshy soil at a distance of about 6-8 inches at the selected restoration site. Ensure that the uprooted vegetation is planted at the selected location within 24 hours.
5. The most suitable period for uprooting and planting vegetation is in September/October, following the monsoon season.
6. Protection of the planted area should be ensured so that the vegetation can propagate and the river bank can be stabilized.

Note: Based on the depicted illustration, the area of R1 is 50 square meters. 800-1000 Patera, Vacha and other native aquatic vegetation can be propagated on this by using the above method. Additional transportation costs may also be required to move the vegetation from the uprooted site to the planting site.

5.3.2 R2

Category Illustration	Length (Meter)	Width (Meter)	Area (Square meter)
R 2	30	50	1500

R2 is the area that starts at the end of R1 and extends to the steep sloping land along the river. It is generally part of the floodplain. The R2 range in the illustration is 30 meters long and 50 meters wide. The most effective way to restore this area is to reintroduce native grasses, shrubs, and water-adapted tree species into the R2 zone.

Species	Type
Vetiver	Grass
Kans	Grass
Jhau	Bush
Kath Jamun	Water Loving species
Katgularia	Water Loving species
Jamun	Water Loving species
Arjuna	Water Loving species
Gular	Water Loving species
Bargad	Water Loving species

R2 Grass / Shrub Propagation Process

1. Get R2 ready for planting by removing invasive species (In June) and marking the designated planting area.
2. Locate regions abundant in Vetiver grass, Kaans grass, and Jhaaun, giving preference to nearby areas for collection.
3. Carefully uproot these species (In September), ensuring you remove the roots and soil. Collect vegetation that is at least 10-12 inches in length, store them securely in a container, and transport them to the chosen planting site.
4. Place them in the designated restoration area, ensuring a spacing of 6-8 inches between each plant and planting them at a depth of at least 2-3 inches in damp or marshy soil. It is crucial to transfer the uprooted vegetation to the chosen site within 24 hours. (within a day).
5. If Vetiver grass seeds are available, these can be propagated on R2.
6. The best time to uproot and plant plants is in September month, or when the intensity of monsoon reduces.
7. It is essential to ensure the protection of the planted area so that vegetation can flourish and the soil of R2 can be stabilized.

Note: Based on this illustration the measurement of R2 is precisely 1,500 square meters. Utilizing the method described, it's possible to propagate approximately 12,000-15,000 grasses or bushes in this space. If you have Vetiver grass seeds, around 250-300 grams of seeds can be used for propagation in this specific area. Additional transportation costs may also be required to move the plants from the uprooted site to the planting site.

R2 Plantation Process

Since the R2 region is submerged during part of the year, the trees found in this region are adapted to survive in water and have extensive root systems and soil holding capacity. Keeping in mind the local context, planting of R2 should be done in two layers.

R2 First Layer

1. The first layer should be right next to R1. In this, Cut Jamun and Cut Sycamore should be planted with a distance of two meters.
2. This layer can be 4–6 meters wide. That means, two-three rows of these species should be planted on the banks of R2.
3. Cut Jamun and Cut Gular saplings are generally not available in forest nurseries so these saplings have to be collected from nearby riparian areas.
4. Cut Jamun and Cut Gular are usually found in abundance at the confluence of R1 and R2 zones and can be planted using vegetative propagation.
5. About 20-25 inches of saplings of these species should be collected from nearby riparian areas.
6. It should be ensured that while uprooting them, their root system and soil remain intact as much as possible.
7. At the selected restoration site, 2-3 plants should be planted together in a 12x12x12 inch pit at a distance of 2 meters. Make sure that just before planting, mix 500 grams of green manure and 50 grams of Neem powder in each pit and plant the uprooted plants at the selected place within 24 hours (within a day).
8. The best time to do this process is in September, or during the time when the monsoon intensity gets reduced.

Note: Based on this illustration the area of the R2 first layer is 300 (6 m x 50 m) square meters. On this, using the above method, 75 pits of 12x12x12 inches will have to be dug at a distance of 2 meters. Additional transportation costs may also be required to move the plants from the uprooted site to the planting site.

R2 second layer

1. As a second layer, large water-adapted trees like Arjun, Jamun, Gular, and Banyan should be planted on the remaining R2.
2. Pits of size **24x24x24** inches should be made at a distance of 3 meters at the selected restoration site. Digging of pits should be done at least 10 to 15 days before tree plantation. These four species can be brought from the nursery of the Forest Department. Annexure no. to the list of nurseries. See Annexure No. 2 for Nursery list.
3. It is important to select good quality plants. If possible, plants at least 2-3 years old should be selected. Because these plants have established root systems and have a high ability to adapt to local conditions.
4. After bringing the plants from the nursery to the selected place, ensure that 1 kilogram of green manure and 100 grams of neem powder is mixed in each pit and the plants are planted within 24 hours (within a day).
5. After planting, use a one meter long bamboo stick to support each plant and cover the tray with weeds or crop residue.
6. The best time to do this process is in late August or September, or during the time when the intensity of monsoon reduces.

Note: Based on this illustration, the area of R2 – second layer is 1,200 (24 m x 50 m) square meters. On this, using the above method, 160 pits of 24x24x24 inches will have to be made at a distance of 3 meters. Additional transportation costs may be required to take the sapling from the nursery to the selected location.

5.3.3 R3

Category Illustration	Length (Meter)	Width (Meter)	Area (Square meter)
R 3	10	50	500

R3 is land with steep slopes, where excessive soil erosion is generally observed. Reviving this high slope area is challenging, as it is most affected during flood-like conditions.

To effectively address soil erosion control and provide post-planting plant protection within the R3 zone, we must bolster it through established bioengineering techniques.

Coir Mat (Bhoovastra or Geotextile) is one such bio-treatment. It has been well accepted for treatment of soil and controlling soil erosion. Coir Mat is easy to install and adheres well to uneven soil surfaces.

Coir Mat (Bhuvastra) installation and planting process

1. First of all get Coir Mat from Coir Board Indore, a Government of India undertaking, phone number – 07312462106. The thickness of Coir Mat should be 700 GSM and size should be 50 meter long and 10 meter wide.



2. Prepare selected R3 for coir mat placement, eradicate invasive species (June) and mark the area.
3. Make pits of 12x12x12 inches at a distance of 1x1 meter at the selected location. These pits have been made for planting bamboo saplings.
4. After digging the pit, ensure that the coir mat is lightly packed and evenly placed on the selected R3 region.
5. Once the coir mat is placed, reinforce the net using 12-15 inch long bamboo sticks. Stick bamboo sticks at a distance of one meter each, at a depth of 5-6 inches near the pits. So that it does not get damaged when faced with strong water flow and remains in place.
6. The process of coir mat installation and digging of pits should be done in September, when the intensity of monsoon reduces. Once the coir mat is established, spread Ankol seed balls over the area.

7. Take locally available Ankol seeds to make seed balls. Take one-fourth cow dung and three-fourth soil and mix it properly. Add water appropriately and make small balls like laddus.

8. Note that the seed balls should be kept moist and coir mat should be made around the establishment. Broadcast the seed balls evenly at the end of monsoon season.

9. Finally, along with propagating the seed balls, plant the bamboo saplings with the help of bamboo sticks in the pre-dug holes. For this, three types of bamboo species, native bamboo, Katang bamboo, and Balcooa Bamboo can be used.

Note: Based on this illustration the area of R3 is 500 square meters. Using the above method a coir mat roll of thickness 700 GSM and size 50 meter long and 10 meter wide will be required. 150-200 grams of Ankol seed balls can be broadcasted on this area, and 500 bamboo saplings can be planted with the help of 500 bamboo sticks. Additional transportation costs may also be required to transport the coir mat (Bhuvastra) rolls and planting material to the selected site.

Note: If the selected R3 area is already vegetated or if coir mat is unavailable for any reason, you can still apply the restoration method described above without the use of coir mat.

5.3.4 R4

Category Illustration	Length (Meter)	Width (Meter)	Area (Square meter)
R 4	40	50	2000

R4 encompasses the upland areas along riverbanks, extending beyond the steeply sloping land (R3). This region caters to various human needs, such as gathering wood and fodder, conducting religious ceremonies (puja), and seeking shelter during the Narmada Parikrama. Moreover, it serves as a vital refugia for wildlife and aids in flood control. Furthermore, by trapping sediments and filtering runoff, it plays a crucial role in maintaining river water quality and recharging groundwater.

R4 has an important role in ensuring the overall well-being of the coastal area. Keeping in mind the local context, planting of R4 should be done in three layers.

The first layer should be right next to R3. Trees with extensive root systems and soil bearing capacity should be planted at a spacing of five meters.

Gular	Pipal	Arjun
Baheda	Harra	Desi Aam
Saja	Bargad	Jamun

The first layer may be 5-10 meters long. That means two-three rows of these species can be planted on the banks of R4.

As a second and third layer, the remaining R4 should be planted with locally found native species. Maximum diversity should be ensured while selecting species.

The following is the list of species of the second layer:

Khirni	Chaar	Khamer
Karanj	Fansi	Harra
Mahua	Sheesham	Ketha
Chirol	Bhilwa	Anjan
Imli	Bel	Kachnar
Siris	Salai	Semal
Amaltas	Beeja	Lasoda
Dhawad	Amla	Khajoor
Kusum	Tinsa	Sindoor
Putrajeev	Rohini	Moyan
Tendu	Bheerra	Reetha

The third layer may be 5-10 meters in length towards the outer edge of R4. That means two-three rows of the following species can be planted on the outer edge of R4.

Chikoo	Amla	Desi Aam
Karanj	Munga	Katahal
Neem	Sagwan	Jamun

R4 Plantation Process

1. Prepare R4 for planting, eradicate invasive species (June) and mark the planting area.
2. Pits of size 24x24x24 inches should be made at a distance of 4-5 meters at the selected restoration site. Digging of pits should be done at least 10 to 15 days before tree plantation.
3. The species given in the list can be brought from the nursery of the Forest Department. Try to ensure maximum variety when selecting plants. See Annexure 2 for list of nurseries.
4. It is important to select good quality plants. If possible, plants at least 2-3 years old should be selected. Because these plants have established root systems and have a high ability to adapt to local conditions.
5. After bringing the saplings from the nursery to the selected place, ensure that 1 kilogram of green manure and 100 grams of neem powder are mixed in each pit and the saplings are planted within 24 hours.
6. After planting, use a one meter long bamboo stick to support each plant and cover the tray with weeds or crop residue.
7. The best time to do this procedure is during June and July or the beginning of monsoon.

Note: Based on this illustration the total area of R4 is 2000 (40 m x 50 m) square meters. The area of the first and third layer is 500 (10 m x 50 m) square meters. Finally the area of the second layer is 1000 (20 m x 50 m) square meters. On this, using the above method, 150 pits of 24x24x24 inches will have to be made at a distance of 4-5 meters. The pits should be dug in a zig-zag manner, as shown in the figure. Additional transportation costs may be required to take the sapling from the nursery to the selected location.

The sample part of each category given under the implementation of the restoration method ends here. If the coordination committee and other village level stakeholders require support in formulating the action plan, they can contact a representative of Indian Grameen Services, the TNC implementing partner, on 7898523831.

Some other important aspects of implementing restoration process

COORDINATION

Effective coordination between the village community and various stakeholders is paramount for the successful restoration of a riparian area. This coordination not only fosters a conducive environment for conservation efforts but also offers valuable guidance in implementing restoration plans. Such partnerships establish a bedrock of mutual trust and robust relationships, facilitating collaboration among different departments, coordination with schemes like MNREGA, and access to both government and non-government resources.

PROTECTION

Protecting the riparian zone before, during and after tree planting is important to ensure the success of restoration efforts. Page 16 provides detailed security parameters that should be followed to successfully protect the riparian zone.

TRANSPORTATION OF PLANT

It is important to handle each plant carefully while transporting it from the nursery to the riparian area. The transportation process requires the following precise steps:

- Avoid clutching plants by their branches when loading and unloading.
- Employ a tray or similar container for loading and unloading.
- Ensure plants are correctly positioned and upright to prevent damage during transportation.
- Regularly water the plants to prevent plant fatalities during transportation and storage.

IRRIGATION SYSTEM

Availability of water and irrigation is critical to ensure the success of restoration efforts. The coordination committee with the support of other stakeholders should focus on providing round the clock irrigation for the coastal area. If no option is available in the coastal area, then help should be taken from the department, distinguished citizens or other non-government/non-government organizations.

In the context of Narmadapuram, riparian areas predominantly coincide with farmlands equipped with borewells. The coordinating body has the option to approach these farmers for water access. They may request the provision of irrigation pipes and rain guns, with assistance from government departments, Jan Abhiyan Parishad, or non-governmental organizations.

MONITORING / OVERSEEING

The restoration work does not end here. For success, the coordination committee/community should assume the following responsibilities.

- Maintain and monitor the coastal area at regular intervals (every three months).
- Make sure that the safety parameters are being followed properly by the community.
- If restoration champions are appointed, review their work regularly and provide them with necessary assistance.
- Know the percentage of plant survival by recording the health of the plants. If survival rates are low, consider corrective measures, including filling gaps and improvising plant protection.
- In addition to measuring the height of individual plants, make sure to document the status of weed control, available irrigation resources, fencing, and protection provisions.
- Evaluate biodiversity by collecting samples and consistently monitor changes through photography.
- Participate in review meetings held at block or district level and share your learnings and challenges.

ANNEXURE

1. Responsibilities of Restoration Champion (Paudh Rakshak)

Providing support to the coordination committee on the following points:

- Assistance in formulation, implementation and monitoring of action plans.
- Assistance in riparian zone classification and measurement.
- Coordination with government officials and other NGOs
- Aids in regular eradication of invasive species
- Assistance in assessment and procurement of planting material and other required materials.
- Assistance in collecting and propagating the vegetation.

To ensure the functioning of the following points:

- Enforce all safety norms on the selected riparian area
- Regular watering of planted vegetation.
- Continuous monitoring and protection of the riparian area
- Marking and digging of the pits in prescribed manner.
- Using green manure and neem powder in prescribed quantities.
- Properly implement all categories of restoration activities described in the guide.
- Making pots on planted plants regularly and covering them with grass.
- Monitor the survival rate of plants.

2. Nursery List

- Khakrapura Nursery - Nursery, Khakrapura Village, Seoni Malwa, Madhya Pradesh, 461881
- Nimpani Nursery - Nursery, Ghorandongri Village, Madhya Pradesh, 460001
- Ahmedpur, Nursery - 80, Hoshangabad Road, Adarsh Nagar, Danish Nagar, Hoshangabad Road, Adarsh Nagar, Danish Nagar,
- Chinar Fortune City, Bhopal, Madhya Pradesh, 462026
- Bansapur Nursery NH 46, Old 69, Budhni, Madhya Pradesh, 466554
- Holipura Nursery – Nursery, Holipura Village, Budhni, Madhya Pradesh, 466445
- Bari Nursery Nursery, Bari Village, Raisen, 464665
- Mudiya Khedi Nursery: Nursery, Mudhiya Khedi Village, Seoni Malwa, 461221

3. List of common, invasive and exotic weed plants of Narmada Riparian Zone

1. Parthenium Hysterophorus, also known as congress grass (Gajar Ghas)



2. Mimosa Rubicalis (Alral/ Aila)



3. Lantana camara (Lantana)



4. Ageratum Conyzoides (Jungli Pudina)



5. Haptis Suaveolens (Vilayati Tulsi)



6. Ocimum Americanum (Van Tulsi)



7. Ipomoea Fistulosa (Besharam)



8. Triumphata Rhobodia (Chikti)



9. Xanthium Strumarium (Chhota Datura)



10. Senna Tora (Chakunda)



11. Argemone (Satyanashi)



12. Martynia (Baghnakh)



13. Mimosa Pudica (Chhuimui)



14. Cuscuta Teflexa (Amarbel)



15. Medicago Polymorpha (Churgali)



4. List of scientific names of plant species given in the guide

R1

Scientific Name	Native (Local) Name
Typha angustata	Patera
Acorus Calamus	Vacha
polygonum/ periscaria Hydropiper	Water Pepper

R2

Scientific Name	Native (Local) Name
Chrysopogon Zizanioides	Vetiver
Saccharum Spontaneum	Kaans
Tamarix Dioica	Jhau
Syzygium Salicifolium	Kath Jamun
Ficus Hispida	Katgularia
Syzygium Cumini	Jamun
Terminalia Arjuna	Arjun
Ficus Racemosa	Goolar
Ficus Religiosa	Benghalensis

R3

Scientific Name	Native (Local) Name
Alangium salviifolium	Ankol
Dendrocalamus Strictus	Desi Bans
Bambusa Balcooa	Bheema bans
Bambusa Arundinacea	Katang Bans

R4 - First Layer

Scientific Name	Native (Local) Name
Ficus Glomerata	Gular
Terminalia Bellirica	Behera
Terminalia Tomentosa	Saaj
Ficus Religiosa	Pipal
Terminalia Chebula	Harra
Ficus Benghalensis	Bargad
Terminalia Arjuna	Arjun
Mengifera Indica	Desi Aam
Syzygium Cumini	Jamun

R4 - Second Layer

Scientific Name	Native (Local) Name
Manilkara Hexandra	Khirni
Pongamia Pinnata	Karanj
Madhuca Longifolia	Mahua
Tamarindus Indica	Imli
Albizia Lebbeck	Siris
Cassia Fistula	Amaltas
Oxalis Latifolia	Dhavad
Schleichera Oleosa	Kusum
Putranjiva Roxburghii	Putijia
Diospyros Melanoxylon	Tendu
Buchanania Lanzan	Chaar
Dalbergia Paniculata	Faansi
Dalbergia Sissoo	Sheesham
Semecarpus Anacardium	Bhilwa
Aegle Marmelos	Bel
Boswellia Serrata	Salai
Pterocarpus Marsupium	Beeja
Phyllanthus Emblica	Amla
Ougeinia Dalbergioides	Tinsa
Soymida Febrifuga	Rohini
Chloroxylon Swietenia	Bhirra
Gmelina Arborea	Gamhar
Terminalia Chebula	Harra
Limonia Acidissima	Kaitha
Hardwickia Binata	Anjan
Bauhinia Variegate	Kachnar
Bombax Ceiba	Semal
Cordia Myxa	Lasoda
Melia Azedarach	Bakain
Mallotus Philippensis	Sindoor
Lannea Grandis	Moyan
Sapindus Mukorossi	Reetha
Ziziphus Mauritiana	Ber
Averrhoa Carambola	Karmal

R4 - Third Layer

Scientific Name	Native (Local) Name
Manilkara Zapota	Chickoo
Azadirachta Indica	Neem
Phyllanthus Emblica	Amla
Mengifera Indica	Desi Aam
Artocarpus Heterophyllus/ Integrifolia	Katahal
Syzygium Cumini	Jamun

5. Implementation Schedule and Timeline

Activities	January	February	March	April	May	June	July	August	September	October	November	December
1. Identification and selection of designated riparian area	✓	✓	✓									
2. Formation of coordination committees	✓	✓	✓									
3. Coordination with government and non-government organizations		✓	✓	✓								
4. Identification and appointment of Restoration Champion (Paudh Rakshak)			✓	✓								
5. Classification and mapping of designated riparian area			✓	✓								
6. Plan– Preparation of action plan				✓	✓							
7. Formulation of norms and bye-laws for conservation			✓	✓								
8. Implementation of conservation norms					✓							
9. Eradication of invasive species						✓	✓					✓
10. Preparation of selected riparian area, marking pit and digging pit						✓ R4			✓ R2 ,R3			
11. Purchase of planting material					✓ R4	✓ R4			✓ R2 ,R3			
12. Installation of coir mat with bamboo stick									✓ R3			
13. Bamboo Plantation and Seed Broadcasting									✓ R2 ,R3			
14. Planting Plants with Bamboo Stick						✓ R4	✓ R4		✓ R2 ,R3			
15. Collection and propagation of planting stock									✓ R1, R2	✓ R1, R2		
16. Watering the plants	✓	✓	✓	✓	✓	Dry period of 7 days **				✓	✓	✓
17. Continuous monitoring and protection of selected riparian areas.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

* List of Planting Materials – (Coir Mat, Saplings, Bamboo Stick, Organic Manure, Irrigation Pipe, Pump, Neem Powder and Seeds.)

* * During the rainy season, if there is a dry period of about 7 days and there is no possibility of rain, then it is necessary to water the plants from an external source.



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