DRAFT

Detailed Project Report (DPR) for Rejuvenation of Yamuna River Through Forestry Interventions

OVERVIEW

Prepared by

Forest Research Institute, Dehradun (Indian Council of Forestry Research and Education)

Project sponsored by

Ministry of Environment, Forest and Climate Change, GoI

OVERVIEW

THE GENESIS

The importance of water cannot be overemphasized. It sustains life and ecosystem. India is blessed with large water resources that comprise 7,57,060 wetlands occupying 15.30 m ha area and 45,000 km long riverine system crisscrossing the country. Rural economy constitutes about 46% of the national economy; the rural economy is majorly agriculture-based and heavily dependent on irrigation water. Yamuna basin is known for a thriving agriculture activity. Yamuna is the fifth longest river of India and is the largest tributary of Ganga. It is a sacred river and has immense cultural, ecological and socio-economic value for the region. With increasing population and rising per capita water consumption, the requirement of water is continuously increasing. Exploitation of water resources is on the rise.

Unsustainable abstraction of water for irrigation, drinking and industries and diversion structures at regular intervals have considerably degraded the Yamuna river ecosystem and modified its flow. The discharge of sewage from households, effluents from industries and inflow of agrochemicals from agricultural fields have deteriorated its water quality. Long stretches of the river witness scanty availability of water during summer while floods occur commonly during monsoon season in many areas. Aquatic biodiversity is seriously threatened, life and livelihood of communities living near Yamuna are adversely affected. The degradation is not limited only to the areas adjoining Yamuna; many tributaries and their feeding springs and streams are also facing the onslaught of various types. There is degradation of forest in the catchment, leading to erosion and higher sedimentation in water.

Water is a renewable resource, however its availability is variable. The world is increasingly facing shortages as well as excesses of water, depending upon time and place, and a general deterioration in water quality. The present situation has arisen because humans have failed to appreciate and recognize rivers as natural ecosystems and forgotten their ecosystem services. It is a paradox that rivers that served as the cradle of human civilisation are now at the mercy of the society for their own well-being.

In the light of the conservation priorities and to achieve Sustainable Development Goals, the Government of India has implemented several programmes to address the problem of water pollution and, in recent years, shown commitment to adopt multi-pronged strategy towards rejuvenation of rivers.

Forests and trees are important modulators of water. Recognising the role of forests and forested landscapes in regulation of the water and related ecosystem services, the Ministry of Environment, Forest and Climate Change (MoEF&CC) has envisioned forestry interventions as means for river rejuvenation. Accordingly, MoEF&CC entrusted the important task to Indian Council of Forestry Research and Education (ICFRE), Dehradun on preparing Detailed Project Reports for rejuvenation of thirteen major rivers of the country, through forestry interventions.

The Detailed Project Report (DPR) on ‘Rejuvenation of Yamuna through Forestry Interventions’ has been prepared by Forest Research Institute, Dehradun (FRI) under the umbrella of ICFRE. The DPR contains a roadmap for restoration of the river on the principles of ecology in consultation with diverse stakeholder groups while seeking to address issues about sustainability and livelihood. It is part of the bigger initiative by MoEF&CC to muster the forestry sector to restore major rivers of the country through activities within the scope of forestry interventions.

THE BLUE: POTENTIAL AND LIMITS OF WATER

The Earth is unique and is also called the blue planet. The oceans, seas, rivers, streams, lakes, ponds, springs, wetlands, and all other water bodies are the reason behind the functioning of the unique ecosystem on the Earth. The water bodies help regulate temperature on the earth and lock carbon dioxide too. Air, water and favourable temperature are three of the most basic factors that make the Earth a unique planet.

Water is the lifeline of all living organisms on the Earth. Water provides myriads of economic and ecological services. Water is a renewable resource, however its availability is variable. The quantity and quality of water have huge spatial and temporal variations. The world is increasingly facing shortages as well as excesses of water, depending upon time and place, and a general deterioration in water quality.

THE DYNAMIC BLUE: RIVER AS ECOSYSTEM

Rivers are flowing bodies of fresh water and are the major source of surface water on the Earth. Rivers transport rain water from the catchments to extensive areas downstream for meeting the innumerable societal and ecosystem requirements. Probably, this is the reason why water resources, especially rivers, have been revered since time immemorial.

Rivers carry water and nutrients to downstream areas and act as drainage channels for surface water, thereby providing habitat and food for organisms like plants, animals, insects, birds, etc. They develop fertile valleys and plains for agriculture and are an important source of hydropower generation. The significance of rivers can be judged from the fact that all important civilisations of the world started in river valleys. The modern industrial economy too is greatly dependent on water of the river systems.

THE GREEN: THE TREES AND FORESTS

Forests occupy large areas on the Earth. They are the abode of countless life forms of various shapes, sizes, habits and abilities. Human being is just one of those species and tends to manage all the natural resources for own benefit.

The forest vegetation comprises not only trees, but also shrubs, herbs and lower plant forms. The number of smaller plants is usually several times more than the trees. The individual effect of those plants is smaller than trees, but together they add up to a substantial quantity and contribute significantly.

Forests provide innumerable economic and environmental benefits. Several timber and non-timber produce e.g. fodder, fuel, gums, resins, tannins, dyes, fibres, drugs, animal products accrue from the forest and drive forest-based industries.

THE INSEPARABLE BLUE AND GREEN

During pristine state of the rivers, most of the earth was covered with forests. The ecosystem services from forests supported rivers in a good state even when civilisations expanded and modern economy took shape.

Water and forests are intimately associated and dependent on each other. Without water, there would be no forests. Without forest, water regulation would be impaired. Forests are important part of hydrological cycle. Owing to ecosystem processes that occur in the forest, the circulation of water is improved and the quality of water is enhanced as it passes through the forest.

Forested watersheds provide an estimated 75% of the world's accessible freshwater resources for agricultural, domestic, industrial and environmental uses. Most of the cities and towns of the world rely on forested watersheds for their water supply.

Vegetation cover has positive effect on river basin. The canopy intercepts rain, decreases the impact of water on the ground reduces soil erosion. Canopy also reduces wind velocity. Litter, organic matter and humus from the vegetation improve the quality of soil, enhance infiltration of water, decelerate surface runoff and increase water-holding capacity. Stem and roots create gaps in the soil, thereby promoting water infiltration and retention. Tree roots hold soil particles and check soil erosion. Roots of some plants remove harmful chemicals from soil and water and store them in plant tree body. Though all plants in a forest have some effect on water, trees have the most dominant role in many ecosystems.

Native vegetation that naturally develops in an ecosystem is well adapted to the site conditions of the area, therefore removing native trees from catchments can adversely impact ecological health, the losses from which may be realised several decades later. Majority of the areas that are facing severe water scarcity are those where forests and trees are currently scarce.

YAMUNA, ITS SIGNIFICANCE AND UNIQUENESS

Yamuna is one of the most important rivers of India and is the largest tributary of the holy Ganga. It originates from Yamunotri glacier at 6,320 m altitude in the Mussoorie range of the lower Himalayas and after traversing 1,376 km joins the river Ganga at Prayagraj. The main tributaries of Yamuna are Rishi Ganga, Hanuman Ganga, Tons, Giri, Gambhir, Godar, Hindon, Jalai, Kalisindh, Mej, Pabbar, Parvati, Sind, Chambal, Banas, Betwa, Ken, etc. Tons in the hills and Chambal in the plains are the most important tributaries from standpoint of water discharge. At Prayagraj, Yamuna pours more water in Ganga than Ganga itself.

Yamuna has huge cultural, economic and ecological significance. Yamunotri is listed among the four prominent pilgrimage places (*Char Dham)* in Uttarakhand. The Prayagraj confluence is a place of religious importance in Hinduism and is referred to as *Triveni-Sangam* (confluence of 3 rivers) though the third (Saraswati) is not visible. Paonta Sahib, Karnal, Delhi, Agra, Mathura, Prayagraj, etc. are prominent places associated with Yamuna in the historical and religious texts. There are several sites of cultural importance along its numerous tributaries as well.

Lives and livelihood of crores of humans, and varied animals and plants in the Yamuna basin are directly or indirectly dependent on Yamuna and its tributaries. The river water is used for irrigation, drinking, bathing, industry, hydropower generation, fishery, etc. Delhi and Agra, two major administrative/tourist centres of India, are located on the banks of the Yamuna. The river mirrors the state of environment and ecology in the mind of people from India and abroad.

RIVER BASIN: THE ECOSYSTEM WHERE YAMUNA PERFORMS

The drainage basin of Yamuna is 366,223 km^2 in size which comprises areas of seven states, viz., Uttarakhand, Himachal Pradesh, Uttar Pradesh, Haryana, Delhi, Rajasthan and Madhya Pradesh. The largest tributary of Yamuna is Chambal which has a catchment area of 1,39,785 km^2.The major portion of the basin lies in semi-arid climatic region. Rainfall and glaciers are the source of water. Larger part of the annual rainfall is limited to monsoon months. Yamuna, with Himalayan area of 11,700 km^2, is both rain- and snow-fed and is perennial in nature. During the non-monsoon season, flow from Himalayan region is mostly due to melting of snow. The glacier area in the Yamuna

catchment is small (i.e., 125 km^2) in comparison with the Indus basin (i.e. 14,043 km^2), this is a reasons behind small stream flow in Yamuna during summer season

Yamuna basin is a conglomerate of varied climatic, physiographic and economic conditions. Glaciers, snow-capped Himalayan mountains, eroded Aravalli slopes, lush green valleys, arid tropical plains, erosion-prone ravines, alpine grasslands, dense temperate to subtropical forests, weed-infested forests, scrub, fertile farmlands, wetlands, national parks, wildlife sanctuaries, urban aggregations, rural areas, industrial, religious, historical and eco-tourism places – a unique and complex mosaic of all such landscapes and features is found in Yamuna basin.

Water resources of the basin can be divided into surface and ground water resources. Availability of surface water in Yamuna basin is 61.22 BCM, of which Chambal (43.67%), Betwa (19.28%), Ken (13.21%) and Sind (3.08%) are the major contributors.

The stream flow of Yamuna and its tributaries varies seasonally and is greatly influenced by human activities and controls. It is nearly negligible between Hathnikund and Etawah during the summer.

The recorded forest area in the Yamuna basin states (comprising Yamuna basin and areas outside Yamuna basin) is 1,85,702 km^2 which is 17.75% of the geographical area of the states. Total forest cover of the states is 1,50,452.44 km^2 amounting to 14.38% of the geographical area. Very dense, moderately dense and open forest constitute 17,565.72, 63201.42 and 69,685.30 km^2 area respectively. The tree cover is 27,157 km^2 which is 2.60% of geographical area of the seven states. The total carbon stock in forests of the seven states is 2,933.37 Mt.

More than 60% area of the basin is the cultivable land. Some of the areas in the basin possess high natural productivity and, consequently, have high population density and economic activity. Water conservation is not a new concept in India. Traditional water conservation and storage structures abound in the Yamuna basin states. However, they are inadequate in number and defunct or poorly maintained in many areas.

YAMUNA WATER: USE, OVERUSE AND ABUSE

Yamuna water is used for irrigation, drinking and industries as well as for bathing, laundry, and cultural/religious activities such as disposal of idols and cremation ash. Since independence, the population in the Yamuna basin has increased by 2.5 times, and to ensure the food security, various irrigation schemes have been developed.

Utilisation of Yamuna water is inevitably associated with problems induced by human beings. The problems of Yamuna are chiefly related to water extraction, flow-regulation, sewage discharge, industrial effluents, agrochemicals, soil erosion, poor infiltration, etc. The catchment degradation, especially the loss of vegetation cover, terrace cultivation, mining, construction activities, also contribute to the alteration of the hydrological regimes and degradation of habitats and water quality.

There are two broad categories of pollution sources in Yamuna water:

Point Sources: A point source is a single, well-defined source which generates a significant amount of pollution or sediment load in river water. Point sources include domestic pollution, industrial pollution and mining. Domestic and industrial pollutions are the largest sources of pollution in Yamuna. Sewage, detergents, oil, grease, organic material, etc. constitute domestic pollution. Untreated industrial waste from a variety of industries in the basin contaminates water. Discharge of hot water into streams or rivers is considered as a thermal pollution and affects microbial population. Mining leads to discharge of silt or minerals in the water.

Non-point Sources: These are diffused sources of water degradation which are unspecified, numerous in numbers and contribution of individual source is quite small. The contaminants of diffused sources include soil, organic material, litter, inorganic and organic chemicals, toxic material,

microbes, ash, etc. Important non-point sources of water degrading factors are (a) agricultural chemicals e.g. insecticides, fungicides, weedicides, fertilisers, (b) garbage, ash and dead bodies, (iii) immersion of idols, flowers, organic material (iv) ash from burning of forest and crop residues, (v) pollution due to in-stream uses of water e.g., bathing, washing of cattle, open defecation and (vi) runoff of soil from agricultural, forest or other lands/ river beds with water or air into stream or river water. Chromium, arsenic and many other metals are present in river water beyond permissible limits of quality standards.

Water quality is an important parameter concerning suitability of river water for diverse uses. Organisms greatly differ in their tolerance to different water quality parameters. As water quality deteriorates, most organisms decline in their population and activity, and a few other organisms tend to replace them.

Low dissolved oxygen concentrations are generally detrimental to aquatic life. A number of other quality parameters viz. biochemical oxygen demand, chemical oxygen demand, suspended solids, pH, temperature, ammonia (NH_3), faecal coliform, heavy metals, pesticides, etc. are also considered while assessing quality of river water.

THE KEY CONCERNS

Human beings have wedged the nature adversely and aquatic ecosystem is no exception. The human-induced changes in the landscape have degraded the sensitive river ecosystems. Insufficient quantity of water in summer, excess water during monsoon, heavy load of silt and pollutants, damage to riverbanks, etc. are some of the problems that have adversely impacted the environmental flow and quality of water. These pose a grave threat to the life-sustaining capacity of Yamuna. Water quantity and quality strongly influence biodiversity. There are major concerns about quantity of water, environmental flow, soil erosion and sediment load, sewage discharge, agro-chemicals, pollution from industries, mining and general degradation of the environment in the Yamuna basin.

Since independence, the population in the Yamuna basin has increased four-fold and the irrigation triplicated to meet the goal of food security. Reports by various agencies suggest that India is already a water-stressed country. The entire Yamuna basin is water deficit (approximately 34.54 BCM deficit). Water shortages, quality deterioration and flood impacts are among the problems which require greater attention and action. In view of limitations on availability of water resources and rising demand for water, sustainable management of water resources including the rivers has acquired vital importance. Addressing the widening gap between water demand and supply is a mammoth task.

Threats like excessive abstraction of water for irrigation and industrial use, pollution from industries and settlements, high rates of sedimentation, etc. thus remain major challenges obstructing environmental flow and ecosystem integrity of the river.

To sustain ecological functions, a minimum continuous supply of water, known as environmental flow, must be maintained. Environmental flows, in general, should at least include the water required for four important components, i.e., ecological requirement, seepage, evaporation, and dilution of pollutants. Environmental flow is an important issue concerning Yamuna.

The major concerns identified in relation to Yamuna, including tributaries, are summarised as under:

1. Poor ecological flow:

The ecological flow of water in Yamuna and its tributaries is greatly impaired: there is excessive water flow during rainy season while the flow is much reduced during remaining part of the year to allow it provide ecosystem services as in the past. The major causes are summarised as under:

a) **Rapid water runoff and inadequate recharge of use during lean season:** The water availability in the Yamuna River is not enough to meet environmental demands during the months of December to June except for the Etawah to Allahabad stretch. From Hathinikund in Haryana to confluence of Yamuna and Chambal near Jalaun in Uttar Pradesh, stretching to about 900 km or two-thirds of the length of Yamuna river, there is hardly any flow of water into Yamuna during the lean season although several small rivers and streams discharge water into Yamuna during the monsoon season. The only major tributary of Yamuna in this 900 km stretch is Hindon, the condition of which is even worse than Yamuna! This indicates impaired state of catchment and poor contribution of rainwater to ecological flow in this region.

Due to increased impervious and paved areas in urban centres, the peak flow of rain water occurs in a relatively short time, resulting in congestion of drainage networks and flooding in rivers. The increasing trend of floods may be attributed to the decrease in basin water retention capacity.

b) **Diversion for agriculture and urban areas:** Largescale diversion of water from Yamuna and its tributaries is taking place to meet requirements of expanding agricultural and industrial activities and to meet domestic requirement of growing population in cities and towns. The change in water flow also hampers the continuous flow of the river.

c) **Excessive groundwater abstraction**: Lack of regulation in the groundwater abstraction has led to ground water table depletion causing damage in causal linkage between surface and ground water, leading to change in surface water dynamics during the lean season of the river.

2. Poor water quality:

There are serious concerns about quality of water in Yamuna as outlined below:

a) **High soil erosion and siltation rates:** Rapid water runoff in the catchment area is associated with soil erosion and damage to river banks. Erosion of topsoil from the catchment reduces fertility and vegetation growth. The off-site effects of soil erosion create problems like reservoir sedimentation and floods at the downstream. The sedimentation at dams and reservoirs depends on the soil erosion rate of the river catchment, thus, the useful life of any hydroelectric or irrigation project is hampered by soil erosion rate in the catchment area.

b) **Discharge of chemicals and waste:** Discharge of domestic sewage, agricultural pesticides and fertilisers, industrial effluents and other waste material such as plastic, ash of dead bodies, religious idols, etc. have been persistently causing pollution of water. This has reduced suitability of water for drinking by man and animals and threatened the survival of aquatic life.

RESOLVING KEY CONCERNS

The key concerns identified above are related to several sectors and need a multi-pronged, multi-sector approach for resolution. While forestry-related concerns have been addressed in this DPR, the following concerns need to be appropriately addressed by other sectors:

1. Poor infiltration of water into ground in agricultural and urban/peri-urban areas causing water scarcity during non-monsoon periods
2. Rapid water runoff due to impervious surfaces leading to floods, damage to landscape, soil erosion and siltation in water bodies
3. Soil erosion caused by disturbance to ground/soil by way of construction, ploughing, mining and other activities
4. Unsustainable exploitation of surface water in farming and urban areas
5. Excessive groundwater abstraction resulting in decline in groundwater status

6. Discharge of industrial chemicals, agricultural pesticides, fertilisers, sewage and other wastes

To some extent, steps have been taken by some sectors, but these efforts may have to be augmented till the goal of river rejuvenated is achieved. A comprehensive list of activities may be worked out by the concerned sectors in consultation with experts and stakeholders. New policies would have to mainstream the water and river conservation objectives and would need to be supported by suitable institutional adaptation.

PEOPLE'S PERCEPTION AND APTITUDE

Yamuna and tributaries have religious and cultural significance in their basins. Despite this, the condition of Yamuna has deteriorated to an alarming state. The river is revered and its water is freely used for various purposes, except for drinking and cooking. In highly polluted stretches, such as in Delhi, it has been reported that people living on river bank revere Yamuna but, on account of diversion of sewer drains into it, do not prefer to use its water for irrigation and other purposes.

However, people want to see a change in the state of rivers. This has translated into actions at the level of government, judiciary and general public. Actions by government and judiciary are described in the subsequent paragraphs. Countless individuals, groups and organisations are voluntarily working in the domain of environmental protection, moisture conservation and plantation activities all over the country, including Yamuna basin.

River Ruparel, a sub-tributary of Yamuna, was rejuvenated by volunteers of Tarun Bharat Sangh (an NGO led by Rajendra Singh, Stockholm Water Prize-2015) by constructing water storage structures. The momentum gained several folds after the appeal from the Prime Minister of India on June 30, 2019 on radio programme *Mann Ki Baat* for water conservation movement. A private company has manufactured an innovative boat fitted with GPS, sensors and image analyser that could detect and collect all kinds of trash, including plastic, chemicals, heavy metals and chemical effluents, and floating debris from the surface of water. The firm has been engaged by the government to carry out cleaning of Yamuna on a commercial scale. The enterprise among the public can be utilised for collective, result-oriented action.

THE POLICIES, LEGISLATIVE AND INSTITUTIONAL FRAMEWORK

India has recognized the conservation significance of its rivers and freshwater resources while realizing the growing demands on these precious natural resources as early as the 1980s when a separate Union Ministry of Environment and Forests was created. Even before this, the Wildlife (Protection) Act, 1972 provided much emphasis on all natural ecosystems (terrestrial, aquatic, and coastal and marine).

World Summit on Sustainable Development (WSSD, 2002) recommended integrated water resources management and water efficiency planning to be essential elements in all national or regional development strategies. Water management figures prominently under Sustainable Development Goals.

Water in India is governed under three different Acts: the Environmental Protection Act (1986), the River Boards Act (1956) and the Inter-State Water Disputes Act (1956). Other Acts and Regulations guide and regulate water resources in different ways by addressing issues of agriculture, biodiversity and conservation and drinking water. Some of these acts are as follows: Indian Forest Act, 1927; Wildlife (Protection) Act, 1972; Water (Prevention and Control of Pollution) Act, 1974; Forest (Conservation) Act, 1980; Environment (Protection) Act, 1986; Biological Diversity Act, 2002, Article 48A and Article 51A (g) of the Constitution of India, etc. The National Forest Policy, 1988; Environment Impact Assessment Notification, 2006; Municipal Solid Waste (Management and

Handling) Rules, 2000; National Water Policy, 2012, Wetland (Conservation and Management) Rules, 2017 are some prominent policies and legal instruments relayed to water and river conservation.

The Hon'ble Supreme Court of India has passed several orders directing the government to take action for controlling pollution and improving lean flow of Yamuna. National Green Tribunal is another body set up by the Govt. of India to address cases pertaining to environmental protection and conservation of natural resources in an effective and expeditious manner. It too has taken several steps towards rejuvenation of Yamuna.

A strong institutional framework is in existence. Water resources are dealt by the Ministry of Jal Shakti, GoI at the highest level. It is supported by organisations such as River Basin Organizations, Central Water Commission, Central Ground Water Board. Forest resources are under the control of Ministry of Environment, Forest and Climate Change (MoEF&CC), GoI which is assisted by agencies like National Afforestation and Eco-Development Board, National Afforestation and Eco-Development Board, National River Conservation Directorate, Indian Council of Forestry Research and Education, State Forest Departments, etc. Other organisations and groups such as Ecological Task Force and Civil Society/NGOs *viz. Nehru Yuva Kendra Sangathan*, National Service Scheme are also effectively working in the area of ecorestoration.

The policy, legislative and institutional framework is quite strong, however, the task of rejuvenation is gigantic one and requires a mammoth, long and sustained effort.

PAST AND ONGOING ENDEAVOURS

A number of programmes and activities have been taken up or are in progress in Yamuna basin. Yamuna-specific project viz. Yamuna Action Plan, 1993 (three phases), *Maily se Nirmal Yamuna Revitalization Plan*, 2017 (2 phases) and National Mission for Clean Ganga, 2018 initiative on Yamuna. Sewage treatment plants (STPs) and effluent treatment plants (ETPs) have been constructed to treat sewage and industrial discharges. Several other steps have been taken to reduce pollution and waste disposal in water and to clean river water. However, discharge of silt or minerals from mining and other activities into water cannot be checked by STPs or ETPs. Numerous state-specific projects have been implemented on treatment of watersheds, sanitation, drinking water, pollution, afforestation, etc.

Water-efficient irrigation facilities and systems are being promoted in a big way in agricultural landscape with a view to reduce pressure on natural water resources. Agroforestry is spreading and getting popularity. A massive number of localised activities on *in situ* moisture conservation and recharge of ground water have been undertaken at individual as well as community levels at various sites in rural as well as urban areas. These include digging of water recharge pits, desilting of existing ponds and lakes, removal of encroachments over land of ponds and village pastures, etc. These acts are expected to have favourable effect on ground water as well as surface water bodies.

Afforestation, forest conservation, soil and moisture conservation, wetland management and other forestry activities are routinely undertaken by SFDs in Yamuna basin and elsewhere every year. Due to efforts of SFDs in conservation and afforestation, forest cover in the seven states has increased during 2003-2019 from 146878 to 150452 km^2 (an increase of 4.48%). After adjusting for change in density of forest cover, the forest cover in terms of very dense forest equivalent area increased from 75216 to 78956 km^2 (an increase of 4.97%) with respect to assessment year 2003. However, there is no evidence of improvement in environmental flow and sediment load of Yamuna and its tributaries.

Significant work has been done in forestry-related activities, yet a lot more is left to be done. For instance, Rajasthan state in 2019 put on record that 130 lakh ha of watershed in the state is yet to be

treated. Hence, while augmenting efforts of the forestry sector, the steps by other sectors and public awareness are also important to achieve the goal of rejuvenation of Yamuna.

However, activities like excess withdrawal of river water or groundwater for industrial and drinking purposes are working towards depletion of water in the Yamuna. Expansion of irrigation network, increasing tendency towards cultivation of water-intensive cropping system, rising use of pesticides and fertilisers, etc. are having adverse impact on quantity and quality of water in the river. Mining and construction and developmental activities also have adverse impact on water. Most of these activities are the result of increasing societal demands for developmental works and water resources. These issues too need to be addressed after striking a balance to realise the goal of restoration of Yamuna.

CAN YAMUNA BE REJUVENATED BY FORESTRY SECTOR ALONE?

To what extent can Yamuna be rejuvenated by forestry interventions, this vital question cropped up and was discussed innumerable times during formulation of the DPR. Forest land constitutes only about 12.5 per cent of the Yamuna basin. Agriculture is the dominant landuse – as much as 52 per cent land is under crop cultivation. Several key concerns outlined in the previous paragraphs emanate from overuse and misuse where forestry sector does not have any role to play or control to exercise. Hence, it is justifiable to conclude that forestry sector alone cannot rejuvenate Yamuna.

The issues challenging the Yamuna are of diverse nature and must be resolved in a holistic manner through participation of all stakeholders. Departments concerned with agriculture, irrigation, flood control, urban and rural development, rivers, water bodies, highways, industries, etc. too need to contribute in their own domains as the authority over 87.5 per cent of Yamuna basin lies with them. Many sectors have, in fact, already been working hard towards this goal. Without participation of all sectors, it would be difficult to achieve the goal. Forestry sector would may provide necessary support to them, wherever necessary, in the multidisciplinary effort to achieve the goal of Yamuna restoration while undertaking forestry interventions.

WHY FORESTRY INTERVENTIONS?

Owing to the rise in demand for forest land to meet the requirements of other sectors of economy and to meet the demand for forest resources by increasing population, there has occurred significant exploitation of forests and degradation of forest in the Yamuna basin in the last century. The degradation has been in form of decrease in forest area and decline in density of forest. The pressure on forest for fodder, fuel, non-timber forest produce, timber, etc. has also increased. The associated problems of soil erosion and higher sedimentation rate in water have inevitably increased. As forest have deep relation with water, the deterioration in forest may also be a reason for poor state of Yamuna and tributaries. Therefore, it is imperative to bring about qualitative and quantitative improvement in forest.

Forests, on huge expanses of land, are intimately associated with water cycle and rivers. It is, therefore, obvious to expect solutions to challenges confronted by Yamuna from the science of forestry.

Effective management of ecosystem allows the conservation of rivers and also sustainably utilizes goods and services within the ecosystem's capacity. It was decided to use forestry interventions for rejuvenation of Yamuna as they provide numerous ecological, environmental and economic goods and services. They would support livelihood of local people in the basin at micro-level and, in turn, help in developing a value-chain and markets at macro-level.

There can be more than one approach to rejuvenate rivers. Engineering structures, if constructed all along river banks, may reduce soil erosion but they would be exorbitantly expensive to make.

Forestry interventions are the cheapest options towards river rejuvenation. They are eco-friendly, they redeem the riverscape and have low maintenance cost. Engineering structures have high environmental costs. Engineering structures lose their effectiveness over a period of time while forests are self-sustaining and gain in effectiveness over a period of time. This DPR, therefore, focuses on forestry interventions.

However, there might be justifiable need to undertake other-than-forestry interventions in many situations, especially in areas outside the forest areas. Those interventions may well be undertaken by respective sectors.

ISSUES CONFRONTING FORESTRY SECTOR

Forestry sector is the custodian of large expanse of land and, hence, can contribute significantly to promoting ecological flow and reducing sediment load in the river water which are the primary concerns of this DPR. The major river-related concerns from point of view of the forestry sector are declining environmental flow and high sedimentation load in river water. These are, in turn, related to the following issues:

a) Forest degradation and landuse change
b) Open and barren catchments/river banks
c) Soil erosion in forest areas and sediment load in river water
d) Presence of invasive weeds and their expansion into adjacent areas
e) Biodiversity concerns
f) Trees outside forest
g) Livelihood issues and generation of industry-level surplus
h) Awareness generation

The strategies for forestry sector were, therefore, formulated to address the above concerns.

DEFINING FORESTRY INTERVENTION

Before developing forestry interventions, it was necessary to define the scope of forestry interventions as this DPR essentially has to prescribe treatments within the domain of forestry interventions. Any activity that is carried out in the forest landscape with a view to improve forest ecosystem, or any activity that is carried out in agricultural, urban or peri-urban landscape involving planting or rearing of tree or woody vegetation was categorised as a forestry intervention.

THE APPROACH

Any DPR on forest and river interface ought to be a joint effort among all stakeholders such as SFDs, other departments such as agriculture, horticulture, soil conservation, rural development, fishery, public works, research organizations, civil societies, NGOs, professionals, farmers, etc. Diverse stakeholders were therefore brought at one platform for a comprehensive DPR on Yamuna.

SFDs have a large network of dedicated staff manning the entire forest landscape and are in charge of every act that occurs there, thus, SFDs were identified as reliable sources of the information for the forest landscape. Their personnel have the power and resources to interact with local stakeholder departments and individuals to collect relevant information for agricultural, urban and peri-urban landscapes in their localities along the river and tributaries. Moreover, SFD would be the primary department that would be expected to implement the provisions of forestry interventions in any state. The SFDs of the seven states in the Yamuna basin too undertook to coordinate with FRI during the DPR preparation process and act as Implementing Agencies (IAs) after the approval of the DPR. SFDs designated their respective Nodal Officers for the coordination. Extensive consultative process

was followed with stakeholders. The approach of preparation of DPR for forestry interventions on Yamuna is illustrated in Fig. 1.

The width of treatment zone (called riverscape) was determined in consultation with stakeholders: the width was taken as 5 km on both sides of Yamuna and 2 km on both sides of tributaries in Haryana, Uttar Pradesh and Madhya Pradesh. The entire catchment area of Yamuna was included in the riverscape in Uttarakhand and Himachal Pradesh, and untreated watershed area identified by Rajasthan SFD was included in Rajasthan's riverscape. In Delhi NCT, the riverscape included area from Yamuna bank upto eastern side of Aravalli ridge. It was, agreed by consensus among all stakeholders that proposals received by FRI from SFDs only would be included in the DPR.

Formats were designed in which proposals were prepared by frontline staff of SFDs. Field functionaries of SFDs were guided on collection of field data and filling of prescribed formats during the meetings with SFDs and also during field visits of FRI project team. Uploading and analysis of the information was done through a data portal. A website was developed to provide information to the public about activities performed.

Geospatial modelling of riverscape was done through remote sensing and GIS tools to understand and quantify the riverscape characteristics. Landsat-8 satellite data for the month of February to April 2019 was used for preparation of land use and land cover maps. The ancillary information was taken from various sources under Government of India. For the identification of the riverscape, the year 2013 was identified as the highest flood level year based on literature review and stakeholder consultation process at various levels. The following layers were prepared: elevation, soil type, soil depth, soil erosion, forest type, forest cover, land use and land cover and patchiness. The riverscape covering an area of 44,070.77 km^2 falling in the seven states in the basin was selected for the purpose of proposed forestry interventions (Table 1).

Table 1. Spatial extent of state-wise riverscape area

State	**Geographical area of state (km^2)**	**Geographical coordinates**		**Area of riverscape (km^2)**	**Per cent of entire riverscape area of Yamuna**
		Lat. ^oN	**Long. ^oE**		
Uttarakhand	53,483	30° 18' 58.157" to 31° 17' 27.673"	77° 34' 32.461" to 78° 37' 30.417"	5087.84	11.54
Himachal Pradesh	55,673	30° 21' 47.190" to 31° 25' 35.568"	77° 04' 26.310" to 78° 18' 25.459"	5,660.36	12.84
Haryana	44,212	27° 52' 32.331" to 30° 26' 44.618"	77° 05' 53.504" to 77° 36' 05.641"	1634.56	3.71
Delhi	1484	28° 28' 44.718" to 28° 51' 47.979"	77° 09' 43.097" to 77° 20' 04.807"	342.79	0.78
Uttar Pradesh	2,43,290	24° 24' 33.437" to 30° 27' 57.912"	77° 16' 54.255" to 81° 52' 56.391"	12,640.77	28.68
Rajasthan	3,42,239	23° 41' 42.590" to 27° 18' 19.584"	73° 32' 10.057" to 78° 12' 31.277"	6755.30	15.33
Madhya Pradesh	3,08,245	22° 26' 08.544" to 26° 54' 12.361"	75° 16' 41.584" to 80° 24' 37.041"	11,949.15	27.11
Total	**10,48,626**	**22° 26' 08.544" to 31° 25' 35.568"**	**73° 32' 10.057" to 81° 52' 56.391"**	**44070.77**	**100.00**

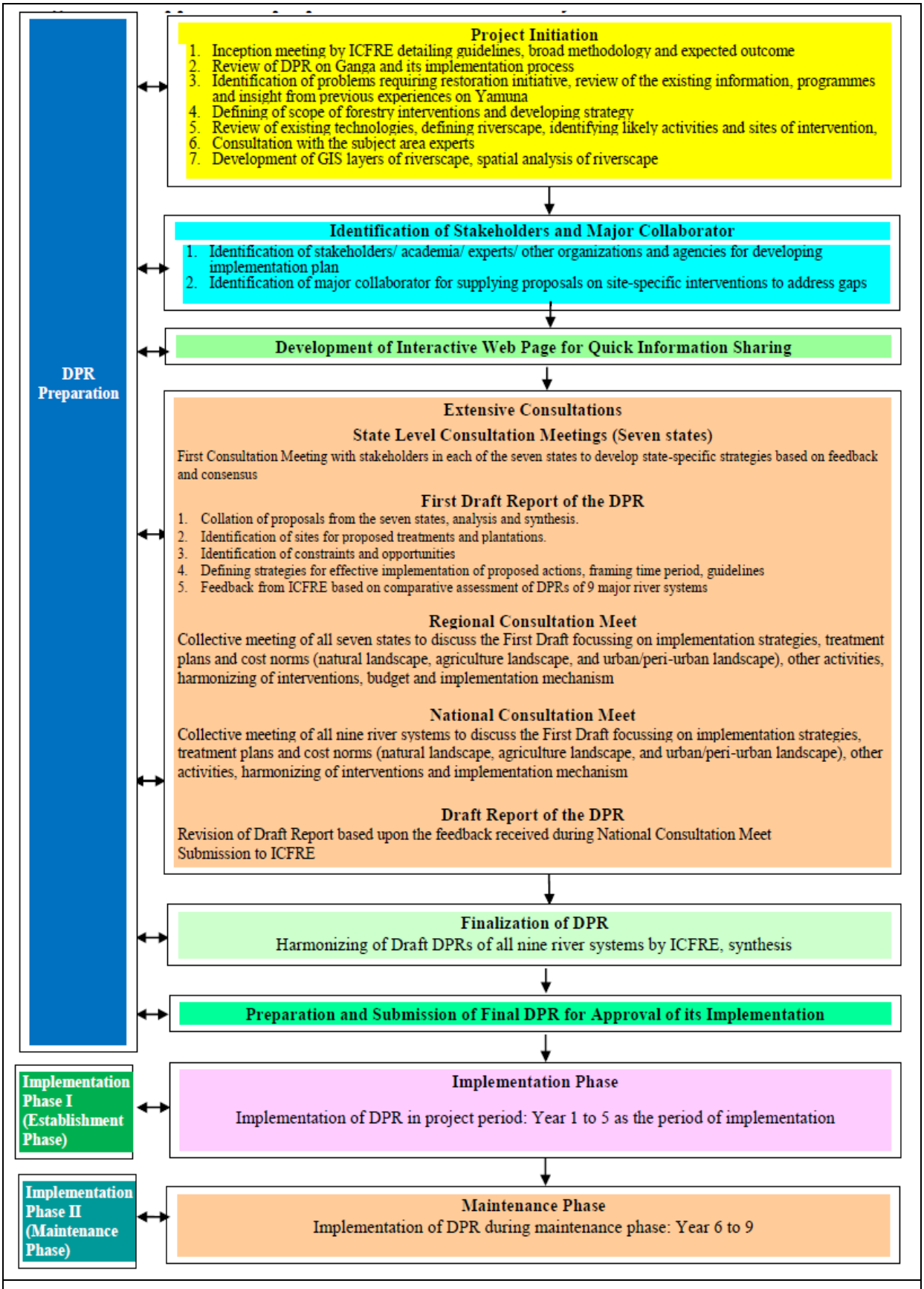

Fig. 1. The approach of preparation of DPR for forestry interventions on Yamuna

Treatment models, budget and implementation mechanism were developed through discussion with field staff and higher officials of SFDs. The same were discussed with SFDs during Second Consultation Meeting with SFDs and finalised.

THE ORGANIZATION OF DPR

The DPR for Yamuna has been formulated in two Volumes: Volume I and Volume II. The Volume I describes the entire background, methodology, prescriptions and expected outcome across the river basin of Yamuna. Volume II presents profiles and prescriptions of the seven states in state-wise chapters for use by the states during execution of DPR.

VISION, MISSION, AIMS AND OBJECTIVES

Vision

To restore degraded forests of Yamuna basin alongwith tributaries to improve ecological flow and quality of river water This follows the approach of *Aviral Dhara, Nirmal Dhara, Swachchh Kinara* of the Govt. of India.

Mission

To establish /develop multi-tier forest of native vegetation and improve ground water recharge in the riverscape of Yamuna and its tributaries

Goals

1. To propose appropriate treatment models (technical prescriptions) for prioritised sites in the riverscape in consultation with SFDs, other stakeholders and experts.
2. To enhance capacity of SFDs to undertake the prescribed project activities in natural, agricultural and urban/peri-urban landscapes.
3. To propose implementation mechanism to MoEF&CC.

Objectives

The objectives of the formulated DPR are as under:

1. To identify key problems in reference to the Yamuna, including its tributaries.
2. To identify a suitable coordinating department that would provide site-specific proposals for treatment of sites in natural, agricultural and urban/peri-urban landscapes in liaison with local stakeholders and would undertake to implement technical treatment models prescribed in the DPR.
3. To develop site-specific treatment models for problem areas in consultation with the above-said coordinating department.
4. To propose funds for implementation of the treatment models and supporting activities.
5. To propose an effective implementation mechanism with potential sources of funding, institutional arrangement and monitoring and evaluation mechanism.
6. To suggest potential benefits in relation to key criteria of ecological flow and quality of water, and associated aspects such as livelihood, green cover, productivity enhancement, biodiversity, etc.

THE LANDSCAPES AND ACTIVITIES

The riverscape was split into three landscape classes viz. natural, agriculture and urban/peri-urban. Plantation activities were proposed for the three landscapes. Besides these, conservation activities were also prescribed independent of landscape. The activities identified to be taken up in three different landscapes under the DPR are as follows:

Natural Landscape: Natural landscape in the DPR implies a collection of forest areas. Activities which are commonly carried out by forest department in forest areas are considered under the purview of forestry interventions e.g. planting of tree, shrub, grass, medicinal plants, underplanting/enrichment plantation, management of bamboo or coppice shoots, assisted natural regeneration, management of invasive weeds, low-cost soil and moisture conservation, riparian wildlife management, wetland management, etc. in forest areas.

Agricultural Landscape: Private and community land in villages are categorised under agricultural landscape. Agroforestry activities in which tree or bamboo is an essential component such as planting of forest trees, fruit and bamboo by farmers in private land and raising plantation in common land in rural areas are included under forestry interventions.

Urban/Peri-urban Landscape: Areas outside forest and agricultural landscape are treated as urban/peri-urban landscape. These activities would essentially include planting of trees or natural grasses in a sizeable part of the treatment site. Activities included are avenue, institutional and strip plantations, bioremediation/bio-filtration; riverfront and eco-park development, riverbank protection, etc.

Supporting Activities: Other activities such as awareness generation, capacity building, monitoring, research, nursery development, development of value chain, installation of watch tower, protection against fire, etc. are essential to facilitate the above activities. These activities have also been treated as forestry interventions.

The DPR is focussed on synergizing the above activities from the point of view of improving water flow and quality of water in the Yamuna and its tributaries.

THE FORESTRY STRATEGIES

The interventions proposed are afforestation activities in natural, agriculture and urban landscapes, soil and moisture conservation measures, riparian wildlife management, wetland conservation, floodplain treatment for stabilisation and greening of the river catchment with native species. Other supporting activities are policy level interventions, monitoring, awareness generation, capacity development, etc.

This DPR attempts to address the concerns about quantity of water, environmental flow, sediment load and environmental degradation around Yamuna (i.e. riverscape) through afforestation and soil moisture conservation, while keeping in view the need for conservation of native vegetation and riparian wildlife, livelihood and income generation for forest-dependent communities and farmers, and improvement in urban/peri-urban spaces.

This DPR has put greater emphasis – than the resent-day practice – on improvement of ground water recharge while raising plantation. Planting of trees, shrubs, grasses, medicinal plants has been prescribed in plantation models in conjunction with soil and moisture works. Models of soil and moisture conservation activities without plantation works have also been proposed in places where plantation activity is not required or plantations have repeatedly failed in the past. The treatment prescriptions incorporate many elements of improvement over the routine afforestation works of the forest department. Models have also been prepared for riparian wildlife management, wetland management, eco park development, riverfront development, etc. The models are site-specific than generalised. Supporting activities that enable the implementation of the above activities were also considered while formulating the strategies together with provision for funds.

THE TREATMENT MODELS

A model is a treatment prescription consisting of several activities suggested for a number of sites with similar site condition and management objective. A total of 142 models/sub-models comprising 49 in natural landscape, 14 in agriculture landscape, 21 in urban/peri-urban landscape and 58 as conservation interventions have been formulated for the riverscape. The number of models/sub-models for different states is as follows: 17 in Uttarakhand, 15 in Himachal Pradesh, 19 in Haryana, 1 in Delhi, 34 in Uttar Pradesh, 28 in Rajasthan and 28 in Madhya Pradesh.

Species recommended in the Working Plan have been prescribed in the models, thereby not recommending use of exotics in the natural landscape. Flexibility is permissible in application of the models to allow adaptation to unique site conditions and improvements based on local experiences while retaining the essence of the model. Use of species that are believed to draw excessive amounts of water or have other adverse effects on water and general environment must, however, be avoided.

In urban landscape, it has been prescribed that the natural layout of the land will be manoeuvred in such a way that the aesthetic beauty will be enhanced without much investment on civil works. Landscaped area will be designed to afford good soil, moisture and biodiversity conservation. *Nakshatra vatika, Rashi vatika, Nav-grah vatika, Panchvati vatika, Dhanvantari vatika,* etc. will be established within the park for awareness generation, meditation and spiritual fulfilment. In riverfront development, plantation of trees, shrubs and grasses will be done to stabilise the riverbank and control soil erosion. The infrastructure in the riverfront would be simple and integrated with the landscape. Under the Wetland Management model, de-siltation will be carried out in wetlands and in their entry-exit channels. Terrestrial and aquatic weeds will be removed and regeneration of native species of trees, shrubs, grasses and other herbs will be augmented. Need-based measures will also be taken to improve habitat and augment the population of native aquatic fauna and control invasive faunal species. Ponds may be created or dug deeper for collecting water to prevent runoff or check inundation in surrounding areas. Water-logging tolerant plant species will be planted wherever possible.

Voluntary public participation would be encouraged by the IAs. Low-cost soil and moisture conservation structures require lot of care in design. IAs would need to guide, support and facilitate the public for collective and technically correct action in this regard.

IMPLEMENTATION OF MODELS

1. Site-specific modifications in the models and site finalisation are permitted provided they capture the essence of the respective models. The rates prevailing in SFD at the site and time of operation would be applicable.
2. Species will be selected in consultation with industries /market experts to plant species that would create industry-level surpluses. Seed or other propagules of forest tree species will be sourced from natural forests and plantations, especially seed orchards, plus trees or seed production areas, wherever available in sufficient quantity, aiming at quality seed. Seed would not be purchased from market for plantation in natural landscape.
3. Soil and moisture conservation measures have been prescribed in most of the plantation models to improve soil moisture. Water storage ponds have been prescribed in few models to increase availability of water for irrigation purpose.
4. During site preparation prior to plantation work, seedlings already growing in the site would be retained, nurtured (through soil working, manure, irrigation operations) and protected. DFOs at time of implementation of the project will have the power to make site-specific modifications in prescriptions to suit the site conditions within the total budget proposed in the DPR for the Division. The flexibility applies to choice of species, site, model, quantity of work and timing of activities.

5. Complete removal of ground vegetation would not be done during rehabilitation of weed-infested areas, Partial removal of invasive weeds would be done followed by artificial regeneration to facilitate gradual replacement of the weeds with economically and ecologically useful species.
6. Organic manure such as vesicular-arbuscular mycorrhiza (VAM), manure will be applied in nurseries and plantations to boost plant growth. Eco-friendly plant protection measures (e.g. physical or mechanical methods, use of natural products, etc.) will be adopted to manage weed and pest without resorting to use of synthetic products. Tall seedlings may be planted to achieve greater survival in areas with high biotic disturbances.

SUPPORTING ACTIVITIES

The following supporting activities have been proposed under the DPR:

1. Awareness generation
2. Capacity building and value-chain development
3. Entry point activities
4. Nursery improvement and fire protection
5. Field activities, contingency and miscellaneous costs
6. Research
7. Monitoring and evaluation

Monitoring may be IT-enabled or on-ground monitoring. The IT-enabled monitoring may be remote sensing & GIS-based or on-line web-portal or App-based monitoring. On-ground monitoring may comprise participatory monitoring at the forest division level and third-party monitoring by external agency. As a policy recommendation for forest areas, it is recommended to develop effective measures for prevention of encroachment, fragmentation of forest areas and muck disposal on forest land. Project Management Unit (PMU) at the state level for Yamuna basin who would do the necessary liaison with MoEF&CC at the state level and DFOs and other officials responsible for execution of the project.

The mid-term review will focus on assessing progress in achieving project outcomes/outputs and deliverables and may suggest measures for further improvement.

INDICATORS FOR MONITORING AND EVALUATION

a) Ecological indicators

1. Area covered under forestry interventions
2. Survival and growth parameters of plants such as height and collar diameter
3. Biomass production
4. Quantitative measure of water in river and other water bodies during non-monsoon period
5. Silt load/soil erosion in treated river basin area
6. Depth of water table

b) Socio-economic indicators

1. Employment generation during plantation and maintenance works
2. Number of awareness generation camps organized and participants
3. No. of training camps and persons of local communities trained
4. No. of training camps and personnel of SFDs and other stakeholder departments trained

5. No. of self-help groups formed and members connected in value chain
6. No. of clusters formed and buyer units/industries connected in value chain
7. Change in availability of forest resources to local population
8. Period of water availability for agriculture and other activities during non-monsoon season
9. Per capita change in income of the stakeholder population

THE IMPLEMENTATION MECHANISM

A 5-year implementation plan (1-5 years from the date of approval/implementation) with further a 4-year maintenance phase is envisaged.

Implementation Mechanism in Forestry Sector

It is expected that MoEFCC may provide the required funds for the implementation of the project, or approach the Govt. of India to allocate funds with support of appropriate ministries or funding agencies. The project will be implemented at national, river, state and district (i.e. Forest Division) levels.

Forest departments in India have a long history and experience of afforestation and reforestation through natural and artificial regeneration. The forestry interventions in the DPR are proposed to be carried out in all the seven states in Yamuna basin namely, Uttarakhand, Himachal Pradesh, Haryana, Delhi, Uttar Pradesh, Rajasthan and Madhya Pradesh. SFDs would play the role of the IAs at the state level and work on ground with appropriate local agencies, organisations and groups. All states in the Yamuna basin will be grouped in Yamuna Cell at MoEF&CC. Forestry sector will implement forestry interventions with appropriate vertical liaison within MoEF&CC and horizontal liaisons with other sectors.

The existing framework within the MoEF&CC will broadly be used for implementation of the DPR on Yamuna for its rejuvenation through forestry interventions (Fig. 2). National River Conservation Directorate (NRDC) or National Afforestation and Eco-Development Board (NAEB) under MoEF&CC may serve as the National Project Management Unit-Forest (NPMU-Forest) on river rejuvenation. A State Project Management Unit - Forest (SPMU-Forest) will be set up at the headquarters of SFD in each of the seven states. APCCF (Projects) may look after the SPMU-Forest. SPMU-Forest will implement the DPR through its hierarchical structure of CCF → CF → DFO.

The participating SFDs would also involve Joint Forest Management Committees, Eco Task Force, Departments of Agriculture, Horticulture, Soil Conservation, Nehru Yuva Kendra Sangathan, *Mahila Mandals*, etc. in programme implementation as considered appropriate by the IAs. Steering committees will be formed at each level. The implementation process of DPR on forestry interventions is described through flow chart (Fig. 3). The Annual Plan of Operations will be prepared by the DFO which will be scrutinised at various higher levels by respective Steering Committees for final approval by Yamuna Cell at MoEF&CC. Upon approval of the APO, the funds shall be transferred against the APO to an account maintained separately by the respective IAs.

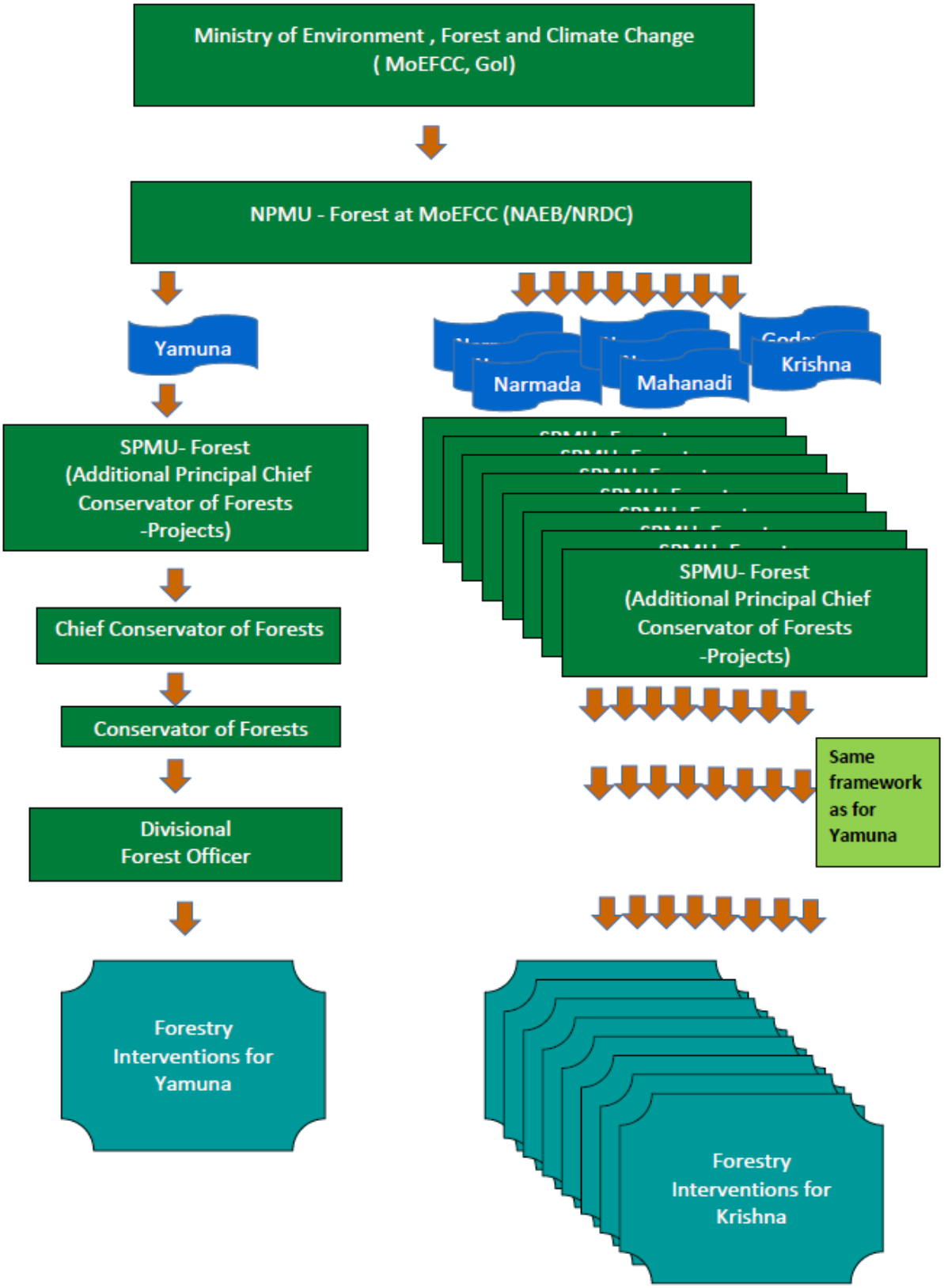

Fig. 2. Institutional framework for implementation of DPR on rejuvenation of rivers through forestry interventions within forestry sector at national, river, state and district levels.

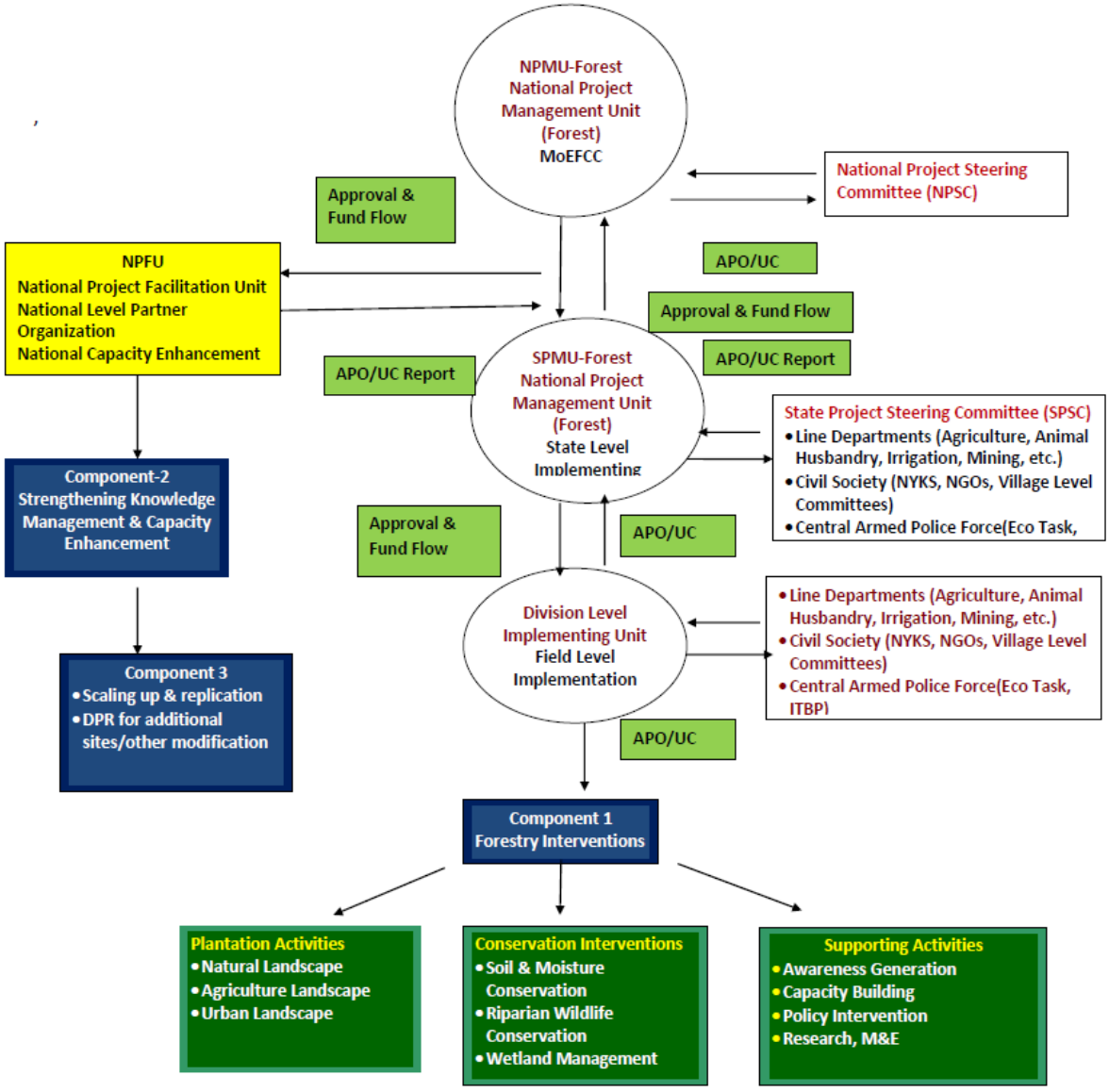

Fig. 3. Flow chart of implementation process of DPR on forestry interventions

Multi-Sector Implementation Mechanism

A multi-sector framework is also proposed to allow coordinated implementation of DPRs of various sectors under the control of a nodal Ministry (Ministry of Jal Shakti, MoEF&CC or other suitable Ministry that may be identified by the GoI). Interventions for various sectors will be implemented by respective ministries and departments with coordination and management by National Project Management Group (NPMG), State Project Management Group (SPMG) and District Project Management Group (DPMG) at national, state and district levels, respectively. Yamuna Cell will be created at national level as well as in relevant states and districts to implement the activities related to Yamuna.

A list of potential funding agencies for different landscapes and thematic areas has also been provided in the DPR

THE BUDGET

The total projected outlay for the implementation phase of project on Forestry Interventions for Yamuna River is Rs. 3,868.89 crore (Table 2). The Component A on Implementation of Forestry Interventions in Riverscape Area of Seven States is Rs. 3,620.05 crore which accounts for 93.57% of the total project budget outlay. Component B on Strengthening Knowledge Management and National Capacity for Forestry Interventions and Conservation of Riverscapes has been allocated Rs. 197.74 crore which accounts for 5.11% of the overall project outlay. The project also envisages Preparation of Follow-up DPR for scaling up, monitoring and replication of successful models of forestry interventions and riverscape conservation in additional sites provided by the state forest departments, for which a sum of Rs. 2 crore (0.05% of the Project budget outlay) has been provisioned as Component C**.**

In order to oversee, steer and manage this important project by the Central Nodal Ministry (MoEF&CC), an amount of Rs. 49.10 has been allocated as Component D which is 1.27% of the projected budget outlay. Thus, it is evident that about 94 % of the budget outlay is meant for field activities on Plantations, Treatment Models, Conservation Interventions and Supporting activities to be implemented by the seven Implementing Agencies (IAs). The financial allocations for Uttarakhand, Himachal Pradesh, Haryana, Delhi, Uttar Pradesh, Rajasthan and Madhya Pradesh are Rs. 123.71 crore, Rs. 105.21 crore, Rs. 67.28 crore, Rs. 10.73 crore, Rs. 451.78 crore, Rs. 2,268.26 crore and Rs. 593.08 crore, respectively.

Thus it is evident that 94 per cent of the budget outlay is meant for field activities on Plantations, Treatment Models, Conservation Interventions and Supporting activities to be implemented by the seven Implementing Agencies (IAs).

Indexing of cost

The budget for the project has been prepared on the basis of rates applicable during April 2020. The cost of the project may be adjusted for the actual date of start of implementation of the project based on Wholesale Price Index (WPI).

Table 2. Component/Activity-wise Budget Allocation

S. no.	Component and/or Activity	Amount (Rs. in crore)	Allocation (%)
A.	**Implementation of Forestry Interventions in Seven States of Riverscape**	**3,620.05**	93.57
A.1	**Plantation and Treatment Models in Three types of Landscape**	**2,043.63**	
A.1.1	Natural Landscapes	1,730.34	
A.1.2	Agriculture Landscapes	220.90	
A.1.3	Urban Landscapes	92.39	
A.2	**Conservation Interventions**	**1,297.29**	
A.3	**Supporting Activities**	**279.13**	
A.3.1	Awareness generation	26.93	
A.3.2	Capacity building and value-chain development	31.14	
A.3.3	Entry point activities	15.11	
A.3.4	Nursery improvement and fire protection	36.83	
A.3.5	Research	21.91	
A.3.6	Monitoring and Evaluation	66.80	
A.3.7	Field activities, Contingency and Miscellaneous Activities	38.56	
A.3.8	Cost of PMUs of Seven State Level Implementing Agencies	41.85	
B.	**Strengthening Knowledge Management and National Capacity for Forestry Interventions and Conservation of Riverscapes**	**197.74**	5.11
C.	**Preparation of Follow-up DPR - Scaling Up and Replication of Successful Models of Forestry Interventions and Riverscape Conservation in Additional Sites**	**2.00**	0.05
D.	**National Coordination for Forestry Interventions and Riverscape Conservation**	**49.10**	1.27
Total Project Cost (A+B+C+D)		**3,868.89**	100.00

The allocation for various plantation and treatment models and conservation interventions (A.1 + A.2) for different states amounts to Rs. 3,340.93 crore (Table 3).

Table 3. Proposed budget allocation for various plantation and treatment models and conservation interventions for different states

States	No. of sites	Area	Cost
Uttarakhand	833	5,219.23	114.33
Himachal Pradesh	551	4,867.38	97.76
Haryana	183	4,890.95	63.07
Delhi	0	0.00	9.04
Uttar Pradesh	878	37,149.56	415.36
Rajasthan	1,688	4,22,806.36	2,099.13
Madhya Pradesh	528	48,048.60	542.23
Grand Total	**4,661**	**5,22,982.08**	**3,340.93**

The allocation for supporting activities (sub-Component A.3) is Rs. 279.13 crore which will be used to meet expenses on awareness generation; capacity building and value-chain development; entry point activities; nursery improvement and fire protection; research; monitoring and evaluation; field activities, contingency and miscellaneous activities and cost of PMUs of seven state level Implementing Agencies (Table 4).

Table 4. State-wise Cost Summary for various activities and PMU under sub-Component (A.3) on supporting activities (Rs. in crore)

States	Awareness generation	Capacity building and value-chain development	Entry point activities	Nursery improvement and fire protection	Research	Monitoring and evaluation	Field activities, contingency and miscellaneous activities	State PMUs	Total
Uttarakhand	0.81	0.87	0.50	1.08	0.78	2.28	1.87	1.19	9.38
Himachal Pradesh	0.72	0.74	0.40	0.73	0.45	1.96	1.45	1.00	7.45
Haryana	0.46	0.47	0.21	0.22	0.33	1.26	0.56	0.70	4.21
Delhi	0.14	0.11	0.00	0.00	0.60	0.18	0.43	0.23	1.69
Uttar Pradesh	3.20	3.75	1.50	5.40	3.35	8.30	5.00	5.92	36.42
Rajasthan	17.50	20.50	7.50	24.00	11.40	41.98	22.00	24.24	169.12
Madhya Pradesh	4.10	4.70	5.00	5.40	5.00	10.84	7.25	8.57	50.86
Total	**26.93**	**31.14**	**15.11**	**36.83**	**21.91**	**66.80**	**38.56**	**41.85**	**279.13**

.

THE EXPECTED OUTCOME

Better ground water regime is expected to bring about improvement in site quality which, in turn, would result in easier plant establishment, greater survival and growth and natural transition of forest communities to later seral stages.

Proposed forestry interventions for rejuvenation of River Yamuna will play a vital role in enhancing the water availability and its quality; control the runoff leading to better recharge of water bodies; and increasing the country's forest and tree cover. Large-scale afforestation activities and other conservation interventions in the riverscape area will lead to increased carbon sequestration, conservation of biodiversity, mitigation of climate change, reduced instances of landslides and erosion, etc.

The potential benefits *ceteris paribus* (i.e. other things remaining constant) expected from the implementation of the DPR are as follows:

Benefits	**Quantity**
Estimated CO_2 capture:	a) 10 Years: 1.69 Mt yr^{-1} b) 20 Years: 2.12 Mt yr^{-1}
Water recharge/ground water recharge:	452.38 MCM MCM yr^{-1}
Sedimentation-reduction:	1,373.98 thousand m^3 yr^{-1}
Non-timber and other forest produce:	Rs. 6,682.98 lakh yr^{-1}
Man-days to be generated over the project period:	74.69 million

Timely and effective implementation of proposed forestry interventions may contribute towards restoring the wholesomeness of the river defined in terms of ensuring *Aviral Dhara, Nirmal Dhara* and *Swachch Kinara*.

Annexure -1

GUIDELINES FOR IMPLEMENTATION OF THE DPR

The 'DPR on Rejuvenation of Yamuna River through Forestry Interventions' shall be implemented in seven states viz. Uttarakhand, Himachal Pradesh, Haryana, Delhi, Uttar Pradesh, Rajasthan and Madhya Pradesh, which are located in the river basin of Yamuna and its tributaries. The SFDs in the seven states shall be the primary Implementing Agencies for forestry interventions. The treatment models and supporting activities, to be implemented in natural, agriculture and urban/peri-urban landscapes, have been described in the DPR. Guidelines for implementation of the DPR are as follows:

1. National Afforestation and Eco-Development Board (NAEB) under MoEF&CC would serve as the National Project Management Unit (NPMU) on river rejuvenation.
2. A State Project Management Unit (SPMU) shall be set up at the headquarters of SFD in each of the seven states. An official of the level of APCCF such as APCCF (Projects) or other official – as may be identified by the PCCF (HoFF) – may head the SPMU. The SPMU shall implement the DPR through the hierarchical structure of CCF → CF → DFO.
3. A separate cell may be created within the NPMU to execute the DPR at river level. In states and forest divisions that would be implementing DPRs on more than one river, cell may be created in SPMU and each forest division to focus on activities related to rejuvenation of Yamuna River.
4. Other departments such as agriculture, horticulture, soil conservation, revenue, etc.; groups such as *Gram Panchayat, Van Panchayat,* NGOs, etc.; and public representatives shall be suitably involved in steering, execution and monitoring of the DPR.
5. A separate bank account shall be opened by each DFO to operate the project funds at division level. Provisions of General Financial Rules (GFRs) and/or any rules/guidelines framed by the central government and state governments from time to time would be followed.
6. A Steering Committee and a Monitoring Committee shall be created at every level. Secretary, MoEF&CC may be the chairperson of the Steering Committee at the national level while the Steering Committee in the state may be headed by PCCF (HoFF). The district-level Steering Committee shall meet at least twice a year at appropriate time for approving the Annual Plan of Operations (APOs) and discussing other issues related to implementation of forestry interventions. Higher level Steering Committees would meet at least once a year.
7. The SFDs would explore funds from various national and overseas agencies. A list of such funding agencies pertaining to different activities in the target landscapes and thematic areas, is provided in the DPR (Vol. I).
8. The SFDs may dovetail activities with similar ongoing /future activities/schemes of various departments (Central/State/NGOs) through appropriate MoUs for creating synergy and avoiding duplication.
9. An Execution Manual would be prepared by the SFD of each state at the start of the project in official language of the state for effective implementation by the frontline staff

of SFDs and other agencies/ workers. The manual would provide all the necessary details for implementation of the DPR as per the provisions of DPR. Wide distribution of the Manual to all concerned field functionaries would be ensured. Capacity building of the involved personnel would be carried out in the proposed efforts towards the river rejuvenation and conservation.

10. The frequency of meetings of Monitoring Committees may be once a year. Monitoring shall have two dimensions: (i) monitoring of project activities and (ii) monitoring for ecological and socio-economic indicators as indicated in the DPR (Vol. II).
11. Project activities shall be monitored through (a) periodic physical and financial reports, (b) IT-enabled monitoring through GIS tools or on-line web-portal or App and (c) on-ground monitoring. The monitoring would be in-house monitoring by the Implementing Agency as well third-party monitoring by external agency.
12. Rejuvenation of rivers requires not only groundwater recharge and soil erosion control in forest areas; it also needs arresting inflow of sewage, pollutants, and pesticides in water bodies, reducing water wastages by various sectors, promoting water conservation and checking soil erosion in non-forest areas. River rejuvenation, therefore, essentially requires participation of several sectors such as **pollution**, agriculture, soil conservation, water and public works, sanitation, etc. Some non-forestry interventions are already being implemented by few ministries/departments. It is expected that river rejuvenation would be mainstreamed in a holistic way in coming years and, as a result of this, all ministries/departments would undertake appropriate measures relevant to their sectors. Therefore, a **nodal ministry** (such as Ministry of Jal Shakti) may be identified by the GoI for multi-sector approach to enable coordinated action on development and implementation of action plans/DPRs of various sectors for river rejuvenation.
13. The project will be implemented with the primary objectives of improvement in environmental flow (e-flow) of water and reduction in sedimentation, rather than greening of the area. Soil and moisture conservation measures and grasses would be given high priority for enhancement of ground water recharge and promotion of favourable conditions for rejuvenation of the entire ecosystem.
14. In an area where both plantation activities as well as soil and moisture conservation works are to be carried out, the soil and moisture conservation works should precede the plantation activities.
15. Prescriptions in the DPR have been prepared after an elaborate participatory approach, even then reasonable flexibility is allowed to address the changing stakeholder needs, national, regional or local priorities, and assimilate learnings from local knowledge, concurrent experiences and research. Best practices of site selection (such as decision support system) and treatment of the site shall be adopted. Ridge to valley approach, that envisages treatment of areas from upstream to downstream, would be followed for site selection and treatment in the riverscape of Yamuna and its tributaries.
16. The DFOs at time of implementation of the project shall have the power to make site-specific modifications in prescriptions to suit the site conditions within the total budget proposed in the DPR for the Division. The flexibility applies to choice of species, site, model, quantity of work, specifications and timing of activities.
17. GPS coordinates of the sites proposed by the SFD at time of DPR formulation are given in the DPR (Vol. II). The sites may be finalised, with suitable changes wherever required, and

geo-referenced at time of implementation of the DPR. APO shall serve as the standard document for GPS location and extent of treatment site for DPR Yamuna.

18. The cost estimates suggested for various treatment models are for guidance and are not intended to serve as actual cost of work for treatment of a site. The wage rate and material cost in force at the time and place would be applicable and reflected in the APO.
19. The mechanism of similar schemes or activities, if any, existing in the state may be adopted as it would allow easier implementation at the ground level.
20. Technical expertise on designing of soil and moisture conservation structures, bioremediation, eco-park development, riverfront development, etc. may be utilised from suitable sources.
21. Incentives, in form of free quality planting material of fruit or forestry plants, and maintenance cost, have been provisioned in treatment models of agriculture landscape for farmers who would plant such trees in their private land. The SFD may, if deemed necessary, explore possibility of providing more incentives from other schemes in operation in the state. Farmers may be allowed to choose tree species and planting geometry for growing trees in agriculture landscape.
22. Quality planting material of superior varieties of fruit species should be supplied to farmers in consultation with the horticulture departments.
23. Indigenous species recommended in the Working Plan should be used in the natural landscape. NTFP and other species that support livelihood may be given priority. Species that are known to consume large amounts of water should be avoided in plantation models. The names of species mentioned in the treatment models are indicative, therefore, planting should not be restricted to the list of species and order of their mention under the model.
24. Cluster approach should be used for production of NTFPs with a view to generating produce at a marketable scale. Value-chain of the species should be developed by the SFD though suitable means.
25. Local, low-cost material must be used for developing soil and moisture conservation structures such as check dam, pond, etc. In models on riverfront development and eco-park development, the use of cement concrete shall be minimised. Stone may be preferred to RCC.
26. Inhospitable and difficult areas would be identified by SFDs and, if available, assigned to Eco Task Force for treatment. Model and geo-location of suitable site would be suggested by the SFD in consultation with Eco Task Force.
27. Places where invasive species are removed should be promptly planted with economically useful species that grow fast and establish easily. Thereafter, the site should be monitored and repeated removal of the invasive species should be carried out on regular basis. This would prevent re-establishment of the invasive species.
28. Effective steps should be taken for conservation of forest and water bodies in the riverscape, including deforestation, illicit felling, control of forest fire, illegal mining in river bed, etc.
29. Public awareness and participation are crucial to the success of the project. Suitable mechanism should be adopted to foster public goodwill and participation.

For Further Details,
Contact:
DDG (Research)
Indian Council of Forestry
Research and Education
Dehradun
Ph: +91-135-2757775 (O)
E-mail: ddg_res@icfre.org