

River Basin Planning: A Case study on Gayathri River Basin , Palakkad District, Kerala
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1. Introduction

Watershed has been accepted as the basic unit for Natural Resource Management (NRM) activities and micro watershed is the smallest possible hydro geological unit where meaningful intervention can be done for NRM. However a better understanding of the sub basins and various micro watersheds in relation to their position within the river basin is necessary for solving problems related to water and for optimum land use and biomass production. It is in this context, Kerala State Land Use Board attempted to prepare a river basin plan of Gayathri river, a tributary of Bharathapuzha spread over mostly in Palakkad and partly in Thrissur District Kerala.

2. Study area

Gayathri River Basin, one among the major tributaries of river Bharathapuzha spread over 980.38 sqkm, 67 microwatersheds traversing the boundaries of 31 Grama panchayaths, 5 Block panchayaths & 2 districts was selected as the study area. Gayathri subwatershed is unique for the following reasons meriting its selection as study area. It is one among the two tributaries sustaining the life of River Bharathapuzha with its origin from portions of Western Ghats, south of Palakkad gap, catchment of four major reservoirs Mangalam, Pothundy, Meenkara and Chulliyar serving the irrigation requirements of the extensive paddy tracts of Alathur, Nenmara and Kollengode blocks of Palakkad district, still rich in its traditional farming and water harvesting systems. The catchment as is the case elsewhere is facing serious threat of deterioration due to human intervention manifested by the fast disappearance of perennality of surface and sub surface water resources.

3. Objective

With the objective of indentifying critical catchments determining the life of the river Gayathri, prioritizing micro watersheds within each sub basin of Gayathri for conservation and rejuvenation efforts and for setting differential strategy for NRM treatment measures in each micro catchment, the river basin plan preparation was initiated with the following approach.

4. Approach

4.a) Clustering within the basin based on tributaries

Gayathri river basin was divided into three clusters based on the catchment of sub tributaries; Cluster I covering Mangalam river a major tributary of Gayathri, Cluster II catchment of Gayathri prior to its confluence with Mangalam river and Cluster III covering catchment of Gayathri after its confluence with Mangalam river.

4. b) Sub clustering into micro catchments

Each cluster was again subdivided based on sub tributaries or sub basins ensuring organic continuity and linkage to the larger basin. The second parameter governing the sub clustering was uniformity in terrain attained through geomorphological characters. Thus Mangalam river basin under Cluster I was sub divided into four at sub tributary level, namely Cherukunnam sub basin, Vandazhy sub basin Ayiloor sub basin and Mangalam sub basin, clustering micro watersheds draining into each of the above tributaries. Cluster II covering catchment of Gayathri river prior to its confluence with Mangalam river was subdivided into 7 sub basins as follows; Chulliyar, Meenkara, Ekshumathi, initial phase of Gayathri , mid phase of Gayathri Cluster III is the last phase of Gayathri that includes the catchment of the river after its confluence with Mangalam River at the border of Thrissur and Palakkad Districts, and its subsequent flow through Thrissur, where it finally merges with Bharathapuzha.

5) Methodology

The plan preparation process was done in a participatory mode. District Panchayath Palakkad took the lead role for coordination of all grama panchayaths, block panchayaths and functionaries of allied departments such as forest, irrigation, agriculture, LSGD and rural falling within Gayathri basin. Plan fund of the three tiers of panchayathi raj system was set apart for logistic support to the plan formulation process. Technical support was fully provided by Kerala State Land Use Board funded by Department of Planning and Economic Affairs, Government of Kerala. Suitable platforms were created at district, block and gramapanchayath level for ensuring the active participation of stakeholders.

5.1) CREATION OF INSTITUTIONAL MECHANISMS

5.1.a) The monitoring committee at Grama panchayath level

The monitoring committee at Grama panchayath level facilitated identification of stake holders and ensured their active involvement for detailed field survey, thematic environment assessment and stake holder interaction. Co operation of functionaries from allied departments at panchayath level was also ensured by this committee.

FRAME WORK

Chairman	–	President, Gramapanchayath
Convener	–	Secretary / Agricultural officer, Grama panchayath
Joint Convener	–	Voluntary community mobiliser/ social worker with experience/ interest in NRM related activities; nominated by the Grama panchayath
Members	–	MGNREGS overseer/ Assistant Engineer Agricultural officer All Grama panchayath members within the study area

Representatives from all micro watersheds within the Grama panchayath

Representative of Irrigation Department of all projects within the study area

Representatives of the concerned Section / Range from Forest Department

Representative of Kerala State Land Use Board

5.1. b) The monitoring committee at Block panchayath level

The monitoring committee at block panchayath level created a common venue for discussion of panchayaths falling within a micro watershed, ensuring upstream downstream linkage, thereby helping to arrive at mutually acceptable solutions. This platform was envisaged also for coordinating the panchayaths for future implementation process, integration of various departmental schemes and convergence of funds for implementation.

FRAME WORK

Chairman	–	President, Block Panchayath
Convener	–	Secretary (BDO), Block Panchayath
Members	–	All Block panchayath members within the study area All Grama panchayath presidents within the study area Assistant Director of Agriculture One representation from each micro watershed within the study area Ward member from the Grama panchayath ward having highest percentage of geographical area within each micro watershed Representative of Irrigation Department from all projects within the study area (Assistant Engineers) Representative of Forest Department within the study area (Range officer) Representative of Kerala State Land Use Board

Roles and responsibilities

1. Coordination of Grama panchayaths at micro watershed level and sub basin level
2. Enactment and monitoring of the execution plan
3. Acting as ideal platform for convergence and integration
 - Integration of functionaries of allied departments at block level (Forest, Irrigation, Rural, LSGD, Agriculture)

- Convergence of all ongoing programmes giving thrust on NRM including plan fund, MGNREGS, IWMP, IPPE, funds of all allied departments, special packages such as RIDF, NABARD, HADA.
- 4. Facilitation for capacity building and skill development to various functionaries/ stakeholders involved in implementation of action plan (NREGS estimate preparation, imparting training to various functionaries of LSGD/ rural for implementation of works requiring technical knowhow from other departments such as Irrigation and Forest, use of QGIS etc.)
- 5. Supervision of WDT (Watershed Development Team)
- 6. Financial support for WDT

5.1.c) The monitoring committee at District Panchayath level

District Panchayath level committee ensured time bound plan formulation by conducting regular meetings, provided administrative sanction for basin plan, final approval of execution plan for future implementation, formal approval by DPC and arrived at consensus regarding the policy decisions to be taken up at different levels

FRAME WORK

Chairman	–	President, Jilla Panchayath
Convener	–	Secretary, Jilla Panchayath
Members	–	<p>All Jilla panchayath members within the study area</p> <p>All Jilla panchayath members who are members of DPC</p> <p>All Block panchayath Presidents within the study area</p> <p>All Secretaries of block panchayaths within the study area</p> <p>All Grama panchayath presidents within the study area</p> <p>All Grama panchayath secretaries within the study area</p> <p>All Grama panchayath Agricultural officers within the study area</p> <p>Principal Agricultural officer</p> <p>Joint programme Co ordinator , MGNREGS</p> <p>District planning officer</p> <p>Project Director, Poverty Alleviation Unit</p> <p>Divisional Forest Officers, all divisions of forest within study area including Wild Life Warden/ National Parks</p> <p>Range officers of all Forest ranges within study area</p>

Executive Engineer, Minor Irrigation

Assistant Executive Engineers of different projects within the study area
Representative from every micro watershed within the study area

Representative of Kerala State Land Use Board

Roles and responsibilities

1. Coordination of block panchayaths, grama panchayaths, functionaries of various departments such as Irrigation, Forest, MGNREGS, DRDA, Agriculture, Soil conservation etc. for plan formulation.
2. Evolved execution plan and chalked out clear cut policy recommendation to all allied departments involved in natural resource management and conservation (forest, irrigation, agriculture, LSGD, geology etc.) at district level and for recommending to be taken at state level.
3. Formulation of supporting Watershed Development Team (WDT) at district level specifically for supervising and providing necessary support for their functioning for plan implementation.
4. Financial support for field work logistics, taking copies of the plan document prepared.
5. Monitoring and implementation of the action plan generated by converging various ongoing programmes (Major and medium irrigation projects, RMF, Green India Mission, working plan and management plan of Forest department).

5.2) CONDUCT OF FIELD SURVEY AND EVOLUTION OF BASIN PLAN

Role of Kerala State Land Use Board

During the preparatory phase facilitated in the formulation of the institutional mechanism and aided in their smooth functioning to empower them to arrive at solutions to overcome the bottle necks that may arise during the process of plan preparation. During the preparatory phase Kerala State Land Use Board played the leading role and went about the process of preparation of the basin plan in a participatory manner with the help of the institutional mechanism already inducted. The distinctive progressive levels within the process of participation of the basin plan are as follows; collection and pooling of all available secondary data, interpreting the data at Land and assessing the status of natural resources prior to start of field survey, detailed field survey with PRA techniques soliciting active participation of the cross section of stakeholders, preparation and finalization of NRM plan at micro watershed level, analysis of data harnessed at micro watershed level by clustering them into sub basin and arriving at the priority for treating the micro watersheds at sub basin level, compiling the results of analysis at sub basin level to generate a comprehensive picture for initiating restoratory activities at river basin level.

5.3) Use of Q GIS

Open source software Q GIS was used for

1. Digitization of all thematic maps
2. Generation of linear, areal and relief aspects of the basins as part of morphometric analysis

3. Generation of intervention map, exact coordinates of all surface and subsurface water resources and manmade irrigation systems
4. Retrieval of data including dimensions when necessary of the environmental themes, water resources, land use/land cover (land use, soil, relief, drainage, irrigation canal network, surface and subsurface water resources etc.) at panchayath ward level in a faster, more accurate manner made possible through digitization. This helped in speedy estimate preparation by MGNREGS officials saving time and alleviating efforts required for gathering essential base data from field

5.4) ANALYSIS OF DATA FOR PRIORITISATION OF MICRO WATERSHED

The data thus generated through detailed field survey that was digitized using QGIS could be analyzed for identification of critical catchments within Gayathri river basin and there by prioritize micro watersheds for under taking NRM activities within each sub basin and to set up differential strategy for treatment of each micro watershed.

5.4.a) Tool employed

The tool employed was morphometric analysis combined with assessment of anthropogenic activities having negative impact on natural resources, especially upon perennality status of stream flow in watersheds.

5.4.b) Assessment of Anthropogenic Intrusions

The anthropogenic intrusions adjudged were depletion or extermination of indigenous flora substituted with species to meet human needs, alteration to the existing land cover, and conversion of paddy lands. Other human intrusions were quarrying along ridgeline, destruction of low elevation hills in midlands, sinking bore wells, mining for clay, dismantling natural drains, encroachment along streams and rivers, conversion of ponds, sand mining from river, excessive pumping from rivers and pollutions of water bodies. Every watershed was assessed for impact due to above activities by ranking the activities prevalent there on a scale of extremely high to moderate and low range. Each range was assigned a score to convert it to a quantitative frame. Aggregate of score received for all impact factors become indicative of the various anthropogenic activities which was found to mar or revoke the natural congenial condition for maintaining the perennality of stream flow in watersheds

5.4.c) Morphometric analysis

Morphometric analysis of a drainage basin gives a very clear picture of inclination of the watersheds towards accommodating the water received through annual precipitation. Morphometric analysis at micro watershed level followed by its comparison against the back drop of sub basin & basin characteristics is essential for identification and treatment of critical micro watersheds. In this context the linear, areal and relief aspects were generated both at micro watersheds and sub basin level using QGIS. The linear aspects analysed include stream order, stream length, mean stream length and bifurcation ratio. The relief parameters analysed include basin length and relief ratio. Areal aspects of the drainage basin analysed were drainage density, stream frequency, elongation ratio, form factor and

texture ratio. The basic parameters like stream length, number of streams, basin area, basin length and perimeter were extracted using Q GIS. The linear areal and relief aspects were calculated using standard mathematical formula (Strahler (1964), Schumn (1956), Horton (1945)

5.4.d) . Result of Morphometric Analysis

The various micro watersheds within each micro catchment were thus subjected to combined analysis of morphometry and impact of human intrusions on natural resources. Thus micro watersheds within the entire basin could be prioritized in the following manner.

Prioritised micro watersheds in different micro catchments

Sub basin	Micro catchment	Total no. of micro watersheds	Micro watersheds with first and second priority	
Cherukunnam	Mangalam reservoir	4	20B39ay	20B39ax
	Upper reach tributary	3	20B39bb	20B39bd
	Middle reach	5	20B39aw	20B39ah
	Lower reach	3	20B39bg	20B39bh
Vandazhy	Vandazhy river	6	20B39aq	20B39at
Ayiloor	Pothundi reservoir	4	20B39an	20B39al
	Bank of Ayiloor river	3	20B39ao	20B39aj
Chulliyar	Chulliyar dam and River	2	20B39s	20B39t
Meenkara	Meenkara dam and river	6	20B39n 20B39m	20B39p 20B39r
Initial phase of Gayathri puzha	Upper reach of Gayathri puzha	4	20B39v 20B39l	20B39m 20B39u
Ekshumathi	Ekshumathi River	8	20B39y 20B39z	20B39aa 20B39ab
Thottupalam Thodu	Thottupalam Thodu	5	20B39h 20B39f	20B39g 20B39e
Middle reach of Gayathri puzha	Middle reach of Gayathri puzha after Ekshumathi	10	20B39d 20B39j	20B39c 20B39e
Last phase of Gayathri puzha (Gayathri after Mangalam)	Karadippara Thodu	4	20B39bh	20B39bk
	Direct to Gayathri	6	20B39a	20B39b & 20B39bl

5.5) EVOLUTION OF CONVERGENCE PLAN AND EXECUTION PLAN

With the help of the institutional mechanisms formulated convergence plan was finalized by linking the NRM activities to be undertaken with the available fund sources with all departments/institutions in the line of implementation. Interdepartmental integration and cohesive action from the part of the

three tier panchayath raj system in enacting the basin plan prepared was attempted through the execution plan that was finalized and formally approved by DPC.

6) STEPS IN PLAN FORMULATION AND EVOLUTION OF EXECUTION PLAN

6. A.) Pre preparatory phase

District Panchayath Committee

- Projectisation- harnessing of plan fund of the three tiers of the Panchyathiraj system
- Formulating and coordinating monitoring committees at district and grama panchayath level consisting of representatives of LSGD, allied departments in the respective levels
- Convening district monitoring committee meeting at regular intervals.

Grama Panchayath Committee

Facilitation for

- Identification and ensuring active involvement of all stakeholders in plan preparation
- Cooperation of functionaries within the panchayath in plan preparation
- Logistic support for conduct of field survey and conduct of interactive workshops.

6.B.) Preparatory phase

Kerala State Land Use Board

- Delineation of micro watersheds and utilization of secondary data
- Collection of secondary data and its utilization (ward boundaries, padasekharams, representatives of various stakeholders, community irrigation systems, organizational set up of forest department, sketch and plan of ayacut area from irrigation department)
- Utilisation of PRM data, toposheets, watershed atlas, soil map for thematic map preparation in digital format
- Thematic environmental assessment through GIS and conduct of PRA at micro watershed level (Panchayath Level Orientation Seminar)
- Field survey at cadastral level using PRA techniques
- Updation of all thematic maps, preparation of present status map and intervention map, conduct of situation analysis to set strategy for differential treatment and arrive at possible interventions, preparation of prioritized list of activities for ensuring discussion at micro watershed level.
- Micro watershed level stakeholder interaction to discuss the intervention possibilities and fine tuning the plan evolved (Micro watershed level seminars)
- Arrived at final priority list of activities to be undertaken at micro watershed level.

Block Panchayath level

- Conduct of Block Level Seminars, participating elected representatives of concerned LSGDs, functionaries of Forest, Irrigation, Agriculture, Rural Departments at block level and representatives of watershed community from each micro watershed within the block

- Integration (spatial, temporal, vertical, horizontal) and convergence possibilities with various ongoing programmes chalked out for all sub basins within the block
- Evolved draft proposal of execution plan for the sub basins.

District Panchayath level

- Close monitoring of the progress of plan preparation through convening periodic meetings of the District Monitoring Committee
- Conduct of District Level Seminars, participating elected representatives of concerned LSGDs, functionaries of Forest, Irrigation, Agriculture, Rural Departments at block level and representatives of watershed community from each micro watershed within the basin
- Finalisation of the execution plan, arrival at consensus regarding policy recommendations to be made at various levels (state, district etc.)
- Approval of DPR of individual micro watersheds, DPR of clusters and execution plan by DPC

7) DATA AVAILABLE

The content of detailed project report of each micro watershed includes, situation analysis with respect to land form, land use, drainage, water resources, canal and problems related to each it's, cause and effects. Data sheet on all drains, surface water resources and sub surface water resources, canal network are available (Data sheet provides information on name of each drain / pond / canal its survey number, location, dimension status, command area, existing structures associated with them, restorative works, its nature, location and dimension.) Data is also available in spatial format using GIS platforms for various themes such as location, cadastral, relief and drainage, soil, land use, present status, interventions at each micro watershed level. Details on prioritized list of activities from the above said are also available in each DPR.

A – Drains (Stream, Thodu)

- Name
- Survey No
- Stream Order
- Land Use
- Perenniality
- Gully Formation
- Activities already undertaken
- Activities to be undertaken with survey no & dimension

B – River

- Name
- Survey No
- Perenniality
- Problems
- Structures
- Pumping
- Activities to be undertaken (Location, dimension)

C – Ponds

- Name
- Survey No
- Name of Padasekharam
- Storage capacity
- Use
- Ayacut area
- No of dependent farmers
- Details of catchment
- Activities already undertaken
- Activities to be undertaken with dimension
- List of prioritized ponds

D. Sub surface irrigation sources (Kuzhi, Potta, Kokkarni)

- Name
- Use
- Dependent farmers
- Status, activities to be undertaken

E – Canal

- Main
- Branch
- CADA
- Direct Sluices
- Survey No
- Irrigation status
- Status of structures
- Activities to be undertaken (location with dimension)

F – Public Well

- Survey No
- Dependent families
- Activities to be undertaken

G- Bore well (Drinking water)

- Name of Scheme
- Survey no.
- Pump set

- Dependent families

LITERATURE GENERATED

- DPR of 67 micro watersheds
- DPR of cluster I,II and III of Gayathri River basin
- Atlas of Mangalam River Basin, Gayathri River Basin, Gayathri after Mangalam
- Mangalam Jalasechana Padhadhi Atlas for Irrigation Department, Palakkad
- Pothundy Jalasechana Padhadhi Atlas for Irrigation Department, Palakkad
- Nenmara Division Vanamekhala Padhadhi Rekha
- Field Guide to the plants in Mangalam River Basin
- Field Guide to the plants in Gayathri River Basin
- “Gayathri – Puzha Samrakshanathinoru Margadeepam” – A hand book

8) PRACTICAL UTILITY

Acts as a base document for river basin planning and NRM programmes (MGNREGS, IWMP, IPPE, PMKSY) aimed at water security , food security and livelihood security converging various agencies and sources of fund

- Delineation of micro watersheds and nano watersheds inside a river basin help in identifying interlinkages among various micro watersheds within a river basin
- Identification of most critical micro catchments (cluster of micro watersheds at sub basin level) sustaining the life of river and setting differential strategy for their treatment
- Identification of critical reaches within each of these micro catchments requiring conservation, rejuvenation and sustainable development e.g.:- patches of forest in ridge area, stretches of paddy fields in special terrain tract (potta, kulambu etc.), networked ponds and sub surface drainage structures within the valley
- Identification of thrust area of treatment suitable for each micro watershed and prioritization of intervention activities to be undertaken within each micro watershed
- Delineation of forest boundary, assessment of land cover rich with indigenous flora within forest land
- Identification of patches of denuded forest suitable for ANR and afforestation initiatives
- Identification of critical catchments of reservoirs for vigilant conservation
- Identification of areas vulnerable to landslides, cautioning human interventions in such areas thereby helping in averting disasters of giant magnitude
- Mapping of boundaries of padasekharams and assessing cultivable fallow, remaining special paddy tracts of critical importance (potta, kulambu) which should be protected through special packages aimed at promotion of paddy cultivation
- Mapping of canal network leading to accurate identification of problems relating to availability of irrigation water that would help in arriving at lasting solutions for improving the conveyance

9) EXECUTION PHASE

- **GO** to link Gayathri river basin plan with MGNREGS activities in Palakkad district

As per order no.1134/EGSC/14/NREGS dated 28/04/2014 administrative sanction was accorded for the implementation of MGNREGS in Alathur and Nenmara block from the shelf of works included in the Gayathri River Basin Plan cluster I

- It was stipulated that special care should be taken for preparing the estimates based on the technical specification and co ordinates defined as part of Gayathri River Basin Plan
- Dissemination of GIS related technical know-how to officials of MGNREGS to empower them for preparation of estimates of works identified by using QGIS maps
- Hands on training was imparted to all the functionaries of MGNREGS from various panchayaths in Alathur and Nenmara block on use of QGIS and retrieval of data from the shape files generated as part of the plan by personnel from KSLUB
- Hard copy of all the 28 micro watershed DPRs of cluster I, Gayathri River Basin Plan along with shape file on all the relevant themes (watershed boundary, ward boundary, interventions, land use, drainage etc.) was handed over to MGNREGS officials by KSLUB
- Subsequent to preparation and approval of DPR of 32 micro watersheds falling in Nenmara, Kollengode, Alathur and partially in Kuzhalmandam block, **circular no. 1134/EGSC/14/REGS dated 6/15** was issued by NREGS for taking DPR of cluster II, Gayathri River Basin as the base document for identifying works for implementation of MGNREGS in the concerned blocks. The soft copy of 32 DPRs have been handed over.
- Continuous sanction was also issued for undertaking works in cluster I
- Practical problems while implementing some of the works selected from the cafeteria were addressed and solutions for smooth implementation (e.g. pond renovation, use of machinery for bailing out water etc.) could be sought in the form of necessary guidelines from MGNREGS mission, during the process of implementation
- **Dovetailing and convergence with IPPE I &II**

Convergence workshop under the chairmanship of **MGNREGS Mission Director** participating elected representatives of district, concerned block, grama panchayath, functionaries of line departments (forest, agriculture, rural, panchayath etc.), representatives of inhabitants of micro watersheds within the basin and personnel from KSLUB was conducted during October 2014

- Protocol for converging IPPEI with Gayathri River Basin Plan could be finalized by identifying safe watersheds, landslide prone areas and enlisting dos and don'ts while selecting suitable interventions for treatment
- **Convergence workshop for converging IPPE II with Gayathri River Basin Plan cluster I&II was conducted on 29/12/2015** where broad indicative suggestions with regard to livelihood opportunities that could be taken up as part of NRLM component of IPPE II was also detailed out along with the strategy for NRM
- In the **circular no.1926/EGSC/14/REGS dated 31/03/16 of NREGA State Mission** issued for conduct of MGNREGS activities during the current year, there is special mention of the continued association with Gayathri Basin Plan. "The present partnership underway in Palakkad by Mahatma NREGA and KSLUB in watershed intervention is a replicable model that can be taken by other districts for river rejuvenation and water conservation"

- Necessary orders for submission of District Convergence Plan for 2016-2017 to State Mission by 10/05/2016 has also been issued by MGNREGS Mission where continued utilization of Gayathri Basic Plan for the purpose is encouraged
- **Preparation of District Irrigation Plan under PMKSY (Pradhan Mantri Krishi Sinchay Yojana)**

District Irrigation Plan preparation ongoing in Palakkad district has utilized extensively the data generated in the Gayathri Basin Plan for computing the water availability and sources of irrigation water available within the basin area. The prioritized list of activities recommended within the basin plan could find a place in the Strategic Action Plan prepared for securing Central Government funds necessary for implementation of the programme in the next five year

10) Missing Links and way forward

- Mechanism for regular conduct of monitoring committee meetings especially at block and panchayath level for reviewing the progress of implementation, sorting out problems connected with evoking active participation and co operation of functionaries of line department (agriculture, forest, rural etc.) has to be developed under the leadership of District Panchayath
- Technical support of concerned personnel from irrigation department and forest department for preparing estimates of items requiring technical sanction involving material components has to be ensured through instructions issued by concerned heads of departments
- Formulation and activation of WDT for implementation of execution plan
- Mechanism for ensuring linkage between WDT, District Panchayath and State government for giving feedback and to obtain timely guidelines and orders for overcoming the bottle necks faced during implementation has to be evolved
- Mechanism for enforcement of vital policy recommendations approved by DPC at district level and state level has to be evolved

PRIORITISATION AT BASIN LEVEL - CLUSTER I, GAYATHRI SUB WATER SHED

By analyzing at sub basin level critical micro catchment crucial to the life of main drain within Mangalam sub basin could be identified. Among the four sub basins, Ayiloor Sub basin is found to be most critical determining the life of Mangalam River basin. Differential strategy for treatment of each micro catchment could also be set taking into consideration the existing land use/land cover, water resources including perennality status, human intrusions and geo morphological characters.

Strategy for treatment of sub basins

Sl. No.	Type of Treatment	Sub basins			
		Vandazhy	Ayiloor	Mangalam	Cherukunnam
1	Conservation & regeneration of Vested Forest	4 th order basin in 20B39aq Ayilimudichi mala	5 th order basin in 20B39ao, 20B39ai Ayilimudichi mala, Edamalakunnu to Pattakunnu	5 th & 7 th order basin in 20B39bg, 20B39ah Kallakkunnu mala, Veezhumala	-
2	Protection of reserve forest	3 rd order basin in reserve forest 20B39ar, 20B39as, 20B39at	3 rd & 4 th order basin in 20B39ak, 20B39al, 20B39am and 20B39an	-	3 rd & 4 th order basin in 20B39ax, 20B39ay, 20B39az, 20B39ba, 20B39bb and 20B39bd
3	Insitu soil and moisture conservation	4 th & 5 th order basin in 20B39aq, 20B39ap, 20B39au	5 th & 6 th order basin in 20B39ao, 20B39aj, 20B39ai	5 th & 7 th order basin in 20B39bg, 20B39ah	6 th order basin in 20B39aw, 20B39bf, 20B39av and 20B39bc
4	Protection of paddy land and networked ponds	Nil	5 th & 6 th order basin in 20B39ao, 20B39aj, 20B39ai, 20B39an	5 th & 7 th order basin in 20B39bg, 20B39bh, 20B39bk and 20B39ah	6 th order basin in 20B39av, 20B39aw, 20B39bc and 20B39bf