INTRODUCTION

Soil and water are the two most precious natural resources for life supporting system on earth. Mother earth gives the protection to these resources through natural vegetation. This protective shield of land is being disturbed by our interference, making soil susceptible to detachment and transportation –a vicious process called soil erosion.

Soil erosion, a dynamic process is the result of both natural and biotic forces operating on earth. The problem is alarming especially in Indian subcontinent, threatening food security due to careless attitude, negligence and unscientific management of natural resources. The increasing biotic pressure on land and over-exploitation of vital natural resources for agricultural and non agricultural needs led to accelerate soil erosion causing large scale degradation of natural resources and the eco-system as well. The development and management of vital natural resources in a sustained manner without impairing its productivity for future generation is the need of the hour.

As early as the 1920's and 1930's, watershed-based planninig practices were adopted by Federal agencies including the U.S. Army Corps of Engineers, the Bureau of Reclamation, the Tennessee Valley Authority, and the USDA Natural Resources Conservation Service (formerly known as the Soil Conservation Service). The NRCS has perhaps the largest national program of watershed management originating from the national concerns in the 1930's over side spread soil erosion and sedimentation.

India began to look at the watershed development programs in the 1970s for increasing land controlling land degradation and increasing the productivity of soils. However, by the end of the 1980s the situation changed radically. Initially watershed projects were concentrating on soil and water conservation issues. A decade later, it became apparent that technical and physical works alone would not lead to the desired objectives of watershed development and the social, financial and institutional aspects of rural development must also be taken into account.

In 1983, a program for development of Dryland Agriculture on watershed basis was initiated and the work began in 47 model watersheds on soil and water conservation measures, crop management and alternate land use systems. After the severe drought experienced in 1987, the Government of India had initiated the National Watershed Development Project for Rain-fed Areas (NWDPRA) in 1990-91 during the 8th Five Year Plan. The programs evolved and the projects designed for using the watershed development approach were the Drought Prone Area Program (DPAP), the Desert Development Program (DDP), River Valley Project (RVP), National Watershed Development Project for Rain-fed Areas (NWDPRA), and the Integrated Wasteland Development Program (IWDP).

In India, more than 70 per cent of annual rainfall takes place during the three months of the monsoon; most of it floods out to sea resulting water scarcity where irrigation is less (FAO, 2010). The Global Runoff Data Centre, University of Hampshire and International Earth Science Information Networks have estimated that around 30 per cent area of the country falls in the extreme water scarce zone having less than 500 m^3/person/year supply of renewable fresh water (Anonymous, 2009).

Though India is blessed with many major rivers and their tributaries but occurrences of flood and drought are regular that caused tremendous impact on food production besides loss of fertile top soil and wealth of the country. It thus calls for both development and management of water resources with scientific data base. Developmental activities in any area are successful only when minute details are acquired scientifically, planned and effectively executed on ground while considering the natural resources of an area for long term sustainability. The natural resources mainly comprises of soil, water, and vegetation resources. Resource conservation planning locally can avert the extreme impacts of climate change and also contribute to the positive side for improving the micro climate of the region to an extent which if integrated at the country level could definitely helps to maintain food security in sustainable way.

The importance of scientific data base for natural resources management is an established fact but the affinity to use the same is limited, that caused all developmental activities short-lived. The advent of remote sensing technology has revolutionized the acquisition of real time earth information by virtue of its capabilities with respect to synoptic view, multi-spectral, multi-temporal and multi-sensor imaging, repetitive coverage and computer compatibility. This technology in conjunction with Geographical Information System (GIS) and global positioning system (GPS) facilitated the generation, management and use of spatial data base for natural resources management on micro-watershed basis.

All Water resource development activities need basic information such as drainage network to derive hydrologic units of various sizes for major and micro level operations for natural resource development.

Concept

The watershed is a natural hydrological entity that covers a specific aerial expanse of land surface from which the rainfall runoff flows to a defined drain, channel, stream or river at any particular point. It is a general phenomenon governed by topography of the terrain. Based on the size, the hydrological units are termed as water resource region, basin, catchment, sub-catchment, watershed, sub-watershed and micro-watershed respectively. Every village or area is a part of one or the other micro-watershed, which is a primary unit of developmental work. Watershed usually covers an area of about 20,000 to 1,50,000 ha that contains many micro-watersheds (500 to 1500 ha size).

For giving practical shape to the systematic, scientific and rational approach of micro-watersheds as smallest units of planning and development, a framework of micro-watersheds is a pre-requisite. It is thus essential to have not only a hierarchical system of delineating bigger hydrologic units with distinct spatial extent into micro-watersheds but also a Unique National codification system also needs to be developed so that each micro-watershed could be identified as an individual entity without loosing linkage with the bigger units, i.e. catchments, sub-catchment, watershed etc., to which it belongs.

The micro-watershed atlas of India will help to justify multi-tier approach, sequenced from ridge to valley for proper implementation of different development programmes/schemes such as Backward Regions Grant Fund (BRGF), Pradhan Mantri Krishi Sinchai Yojana (PMKSY), Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), Afforestation Schemes, etc. with Integrated Watershed Management Programme (IWMP) for treatment of forest areas.

The concept of stream order is often followed in geomorphic analysis of natural drainage system. However, a framework of micro-watersheds for development purposes requires a different approach indicative of macro and micro level of delineation. Each of the big drainage systems needs to be divided and sub divided through stages. One way to identify each subsequent stage of sub division could be the mathematical terminology system, but a more understandable approach would be to use different codes to indicate various stages starting with macro-level and going down to micro level.

The terms catchment, sub-catchment, watershed etc. are often synonymously employed because all describe the areas defined by a single river system. Yet they could be meaningfully applied for denoting various stages of delineation from macro to micro levels.

The size of different hydrologic entities is governed by the size of the stream or river or the point of interception of the river like a dam, barrage, etc. For example, the size of the Mahanadi river basin is 145 lakh ha. Whereas the size of the catchment of Hirakud dam on Mahanadi is 83 lakh ha. The size of micro-watershed and sub-watersheds of watersheds is of practical importance in land and water resource development which is defined by the aims and objectives of a particular development programme. The size of smallest hydrologic unit while delineating bigger system into micro-watersheds/ sub-watersheds could be restricted to viable size dictated by the working feasibility.

Keeping in view, the allotment of *Unique National Code* to each micro-watershed for the working feasibility of the different implementing agencies in the country, Soil and Land Use Survey of India (SLUSI) under Department of Agriculture, Cooperation and farmers welfare, Government of India, has entrusted the task of preparation of Micro-watershed Atlas of India on 1:50K scale, in digital as well as hard copy. Enormous volume of spatial data of entire country was entered and analyzed in GIS environment, which led to delineation and codification of micro-watersheds in the country. Accordingly, the delineation and codification Micro-watershed Atlas of India is carried out at up to micro-watershed level following same methodology of the Digital Watershed Atlas of India, published by the organization to maintain the uniformity at all levels.

The atlas will provide district -wise list of micro-watersheds within a viable size of a hydrological unit for planning and management of developmental activities in the country. The Micro- watershed Atlas of India has been designed in such a way that user shall be able to locate and identify the micro- watershed of his interest falling in any district of the country.

Need for Development of Micro-Watershed Atlas

An important observation emerging from various experiences and past efforts in watershed development is that expertise are available in the country to address all dimensions of watershed development, but the line departments prepare their plan with state own hydrological framework and often there is no inter-department coordination. Secondly, absence of real time database for assessment of natural resources such as hydrology, land, and water at micro-watershed level i.e. at large scale in

various river basins of the country. Therefore, a national hydrological framework is essentially required for bringing uniformity in the execution of watershed development and evaluation to study the impact of watershed schemes.

The advent of emerging geospatial technologies aids in developing action plans scientifically as it provides real time information on natural resource data acquired through high-resolution satellite data (1:50,000 scales). This facilitates the watershed monitoring and impact assessment of the watersheds project. This will help in assessment, management and monitoring of watershed projects efficiently.

Considering these facts and responding to the consistent demand for the national framework of Micro-watersheds by the user agencies in standardized formats, Soil and Land Use Survey of India (SLUSI). Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India has developed a methodology for systematic delineation and codification for generation of micro-watershed atlas with 1: 50,000 scale with interactive web-based display development which would not require expensive GIS software to provide micro watershed-wise information to the local user department via internet to prepare the action plan for the area of interest.

Basic Design of Present Initiative the Micro-Watershed Atlas of India

The major landmark works in watersheds was done by the All India Soil and Land Use Survey (AISLUS) presently known as SLUSI (Soil & Land Use Survey of India), Dept. of Agriculture, Cooperation and Farmer's Welfare. A National Level Watershed Atlas on 1:1 million scale was published in 1990 using the base map generated from Irrigation Atlas of India (AIS&LUS, 1990). This atlas has been extensively used in the country for various purposes. These maps were available in hard copy and require digitization for integration in GIS platform.

Afterwards based on the demand of digital spatial data for effective implementation of all land based development programmes, revised second edition of 'Watershed Atlas of India' was published by Soil & Land Use Survey of India (SLUSI) in 2012.

It contains hydrological units of the country categorised in five stages *viz*. region, basin, catchment, sub-catchment and watershed. The river systems of the country have been divided into 6 water resources region *viz*., Indus drainage, Ganges drainage, Brahmaputra drainage, all drainage flowing into Bay of Bengal except the Ganges and Brahmaputra, all drainage flowing into Arabian Sea except the Indus and the ephemeral drainage in Rajasthan. These have been further divided into 37 basins and 117 catchments, 588 sub-catchments, 3854 watersheds, 49618 sub-watersheds and 321324 Micro-watersheds.

There exists large variation in criteria, methodology and objectives in delineation of hydrological units in the country among various organisations. The attempts made so far for delineation of hydrological boundaries up to watershed level which obviously have some limitations.
Due to lack of detail drainage on large scale base map (1:10K), precise delineation of watershed was not possible. However, for effective implementation of water resources development scheme at grass root level there is growing requirement of a larger scale map. Preparation of a Micro-watershed atlas on 1:50 K scale considered appropriate at present because the availability of standard 1:50,000 scale map series in the country, and all the thematic maps are being produced on same or larger scale. In this context, hydrological units have been delineated precisely using larger scale drainage network from Survey of India topographical maps (1:50,000), and were checked using Digital Elevation Model (DEM).

'Micro-Watershed Atlas of India' on 1:50,000 scale will be an important digital database for planning and monitoring of development programmes being implemented in the country on watershed basis. This will provide the Distinct Spatial Extent and Unique National Code to every micro-watershed of the country. Similarly, a systematic and scientific delineation along with its hierarchical alpha-numeric codification is useful for watershed management programs at village levels. The average size of micro-watershed is 500 to 1500 ha considered best for the government programs. It will serve as a uniform baseline for developing hydrologic unit based data bank to be used for water resources management. Runoff, sedimentation, water balance, and several other catchment characterizations related studies on micro-watershed basis.

It helps in ensuring uniformity in the use of micro-watershed code across the nation in the soil and water conservation and management programs. The spatial micro-watershed atlas of India developed with 51490 sub-watersheds and 320628 Micro-watersheds. Each one is having distinct spatial extent with unique national code helps to avoid duplication of activities with similar objectives under different ministries in one micro-watershed. These hydrological unit boundaries with codes can be used by various organisations involved in development activities related to integrated development of water resources and management on watershed basis. The hydrological unit boundaries with unique codes up to micro-watersheds can be downloaded from the organization website (http://slusi.dacnet.nic.in) free of cost.

DELINEATION AND CODIFICATION OF MICRO-WATERSHED

Materials

The Atlas has been developed using the following base materials.

Base Data

- Watershed Atlas of India (1990)
- Watershed Atlas of India (2012)

Hardware

- CONTEX Wide Image Scanner
- HP Workstation
- HP designjet Plotter

Software

- ArcGIS - GIS Software
- Microsoft Office Access - RDBMS Software

Hierarchical System of Delineation of Micro-watersheds

SLUSI has initiated delineation and codification of micro-watersheds in the country since launching of Centrally Sponsored Scheme on Soil and Water Conservation in the catchments of River Valley Project during III Five Year Plan. The delineation of micro-watershed is carried out following **Hierarchical System of rivers/streams** based on drainage network. The codification of micro-watershed is done following **Alfa-numeric System**.

Methodology

The systematic delineation and codification of micro-watersheds have been done starting from bigger to smaller hydrologic unit following stream heirarchy. The delineation of the entire river systems of the country made by Dr. A. N. Khosla, Central Water and Power Commission (CWPC) in 1949 has been taken as base for preparation of Micro-watershed Atlas of India by Soil and Land Use Survey of India (SLUSI). According to the system the whole of country was delineated into six Water Resources Regions:

- Region No.1: Indus Drainage
- Region No.2: Ganges Drainage
- Region No.3: Brahmaputra Drainage
- Region No.4: All Drainage flowing into Bay of Bengal except those at 2 & 3
- Region No.5: All Drainage flowing into Arabian Sea except that at 1
- Region No.6: The Ephemeral drainage in Rajasthan

Delineation of Micro-watershed

The delineation has been done in 7 stages starting with Water Resource Regions (WRRs) and their subsequent division into Basins, Catchments, Sub-catchments, Watersheds, Sub-watersheds and Micro-watersheds using drainage network on 1:50K scale. The stages of delineation are described below. The delineation of watershed has been carried out following stream hierarchy on the basis of drainage network.

- The water resources regions are segregated and the codes 1 - 6 have been assigned (**6**).
- Each water resource region is divided into different basins. In some of the cases, where the drainage systems are too large, basin is divided into lower and upper basins or left bank and right bank basins (**37**).
- The basins have been further subdivided into number of catchments, which mostly pertain to main tributaries or a group of contiguous small tributaries or individual streams (**117**).
- As a fourth stage of delineation, the catchments are further divided into a number of sub-catchments which are mainly smaller tributaries and streamlets **(588)**.
- Each sub-catchment has been subjected to further divisions into number of watersheds (**3854**).
- Watersheds are further subdivided into sub-watersheds **(49618).**
- In seventh and last stage of delineation, the sub-watersheds are subdivided into micro-watersheds **(321324)** which have been taken as the smallest hydrologic entity.

The delineation up to micro-watershed on 1:50K scale is depicted in fig. 1 to 7 below:

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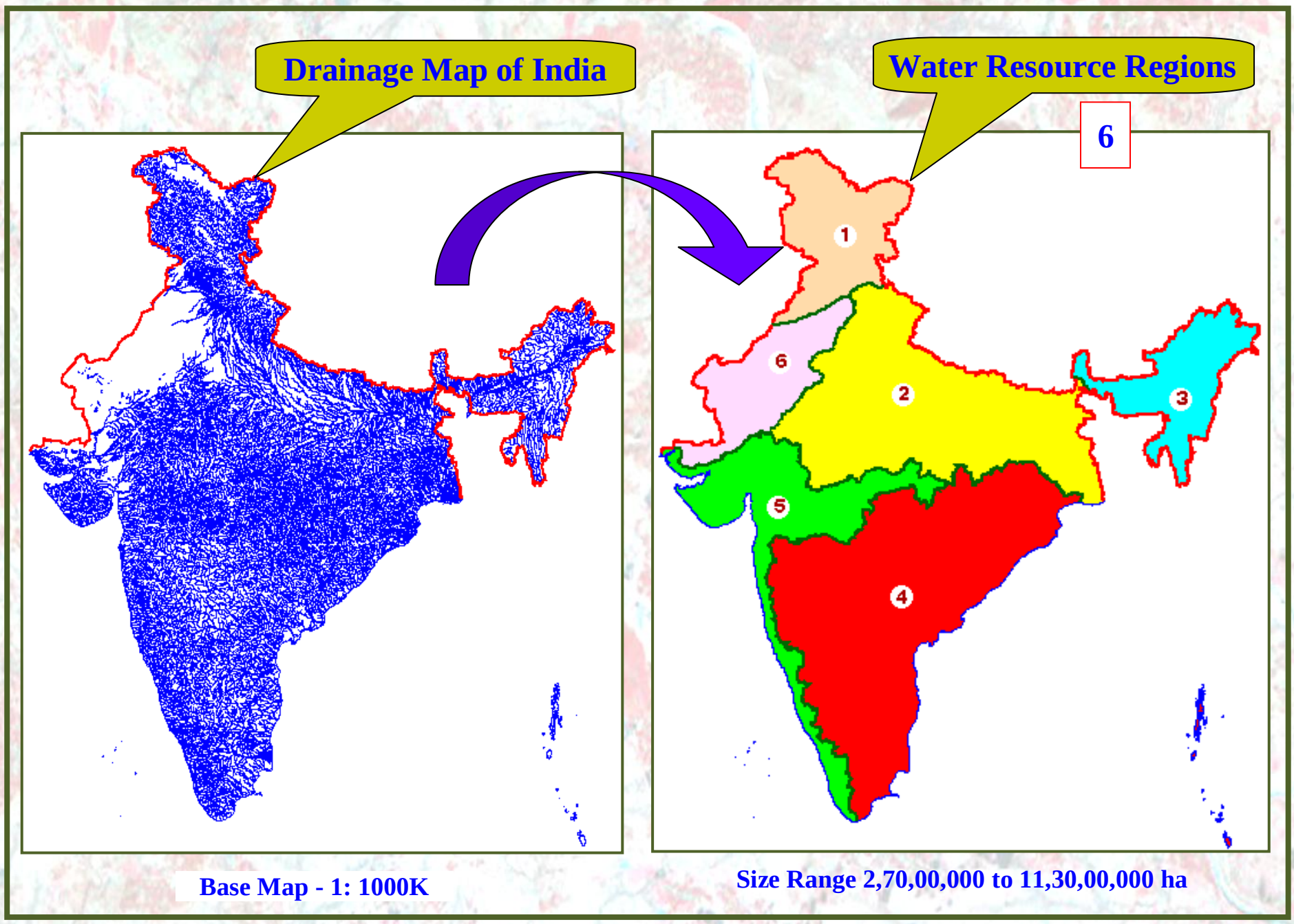

Fig. 1 Delineation of Water Resource Regions from Drainage

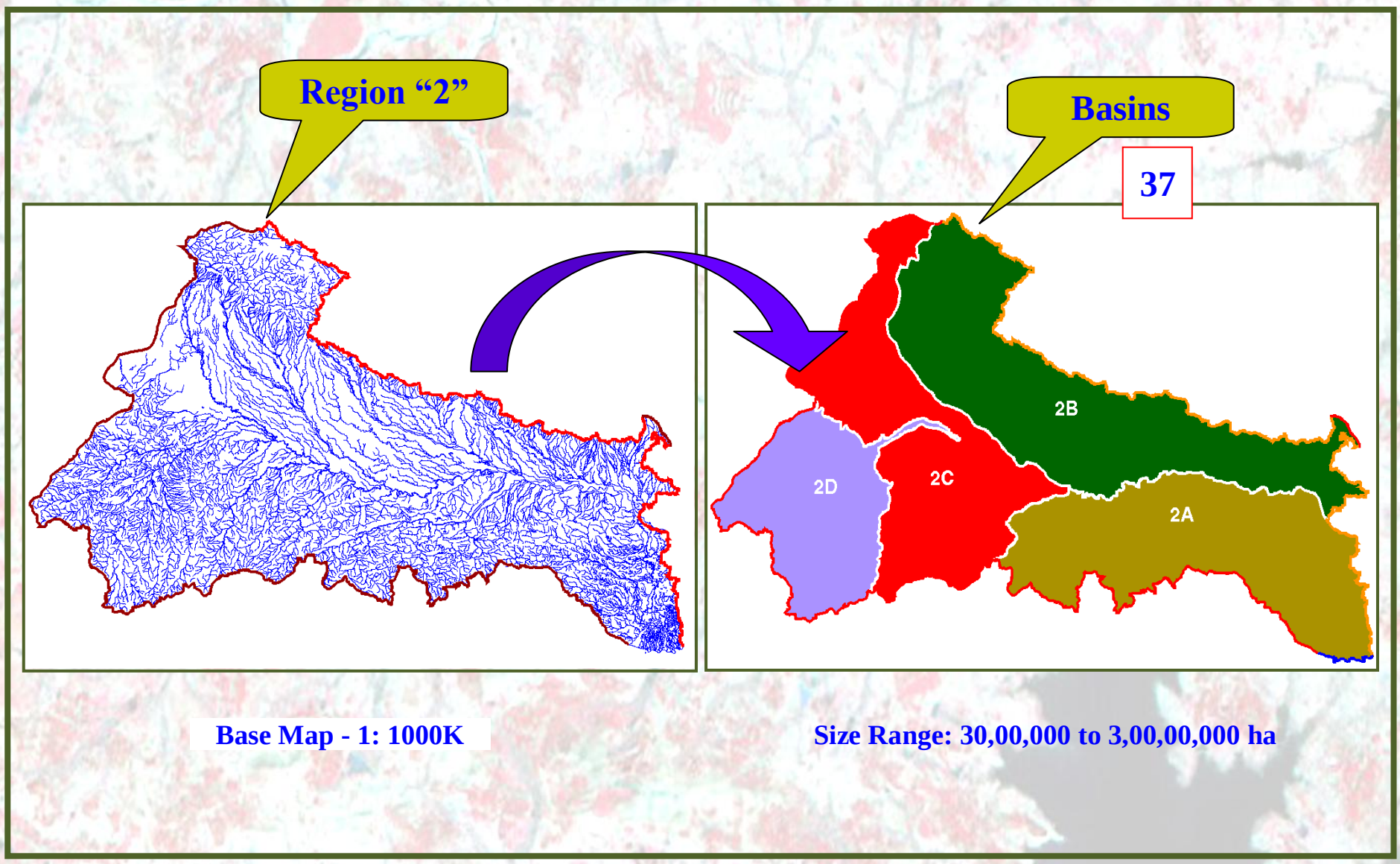

Fig. 2 Delineation of Basins from Region

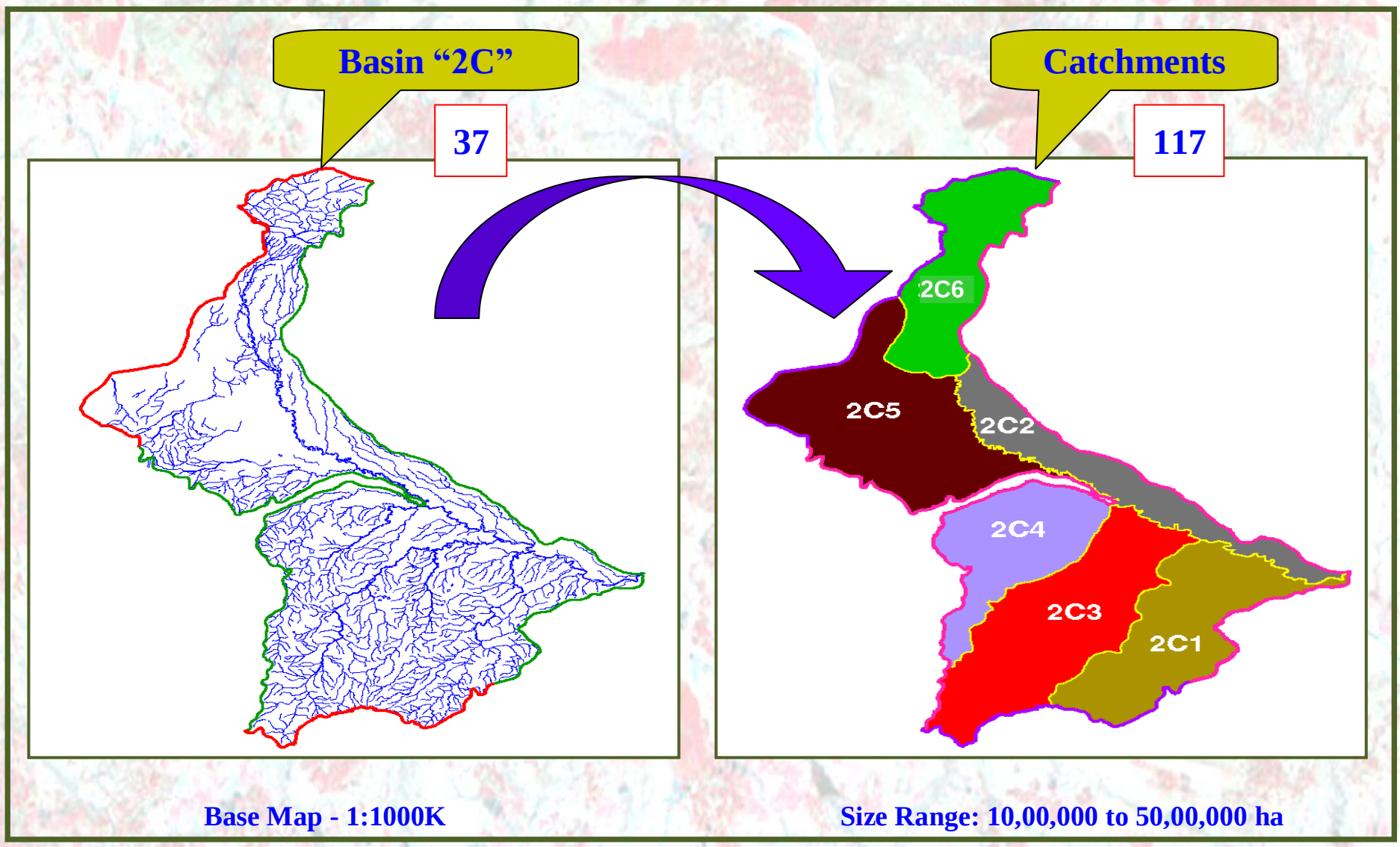

Fig. 3 Delineation of Catchments from Basin

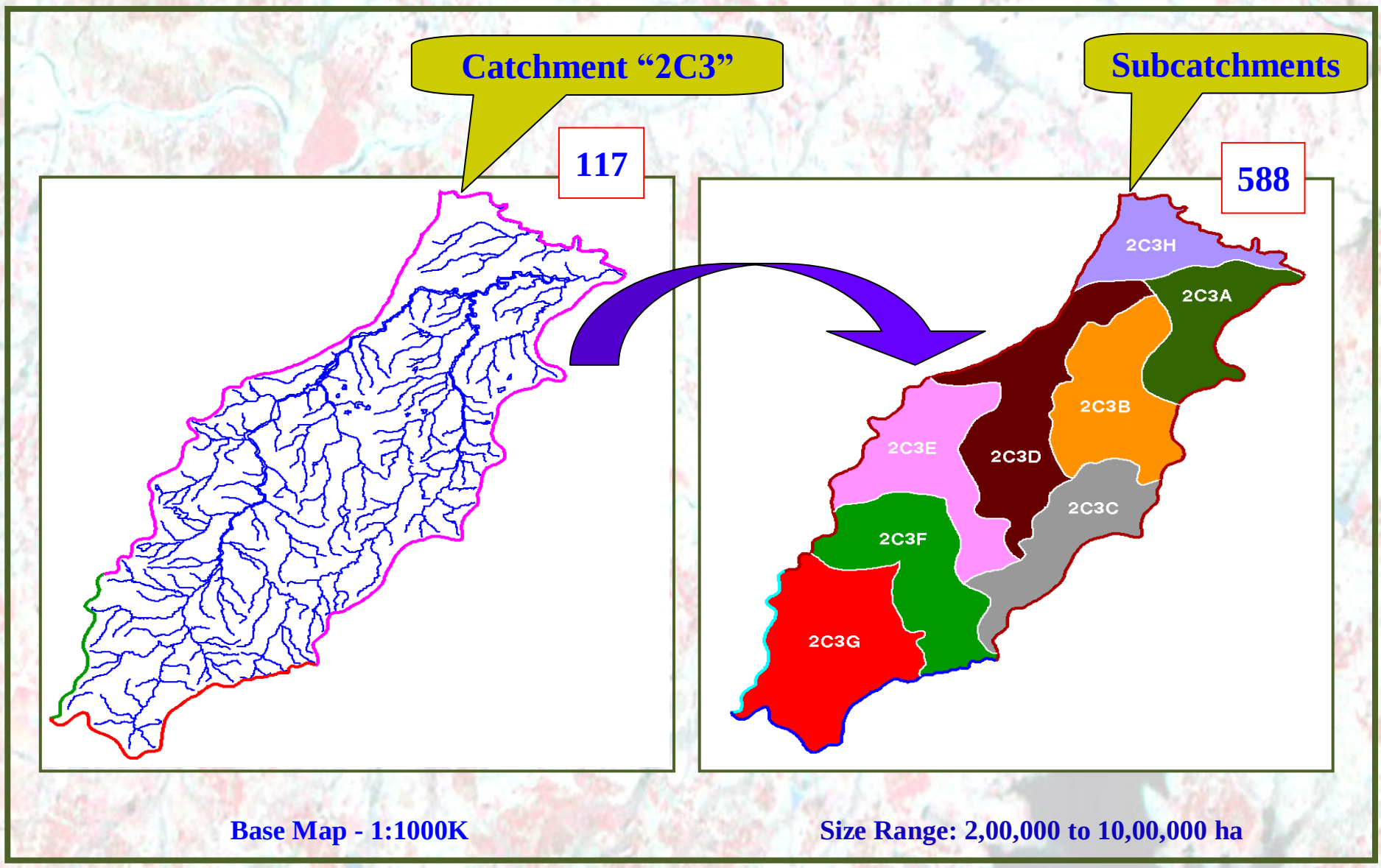

Fig. 4 Delineation of Sub-catchments from Catchment

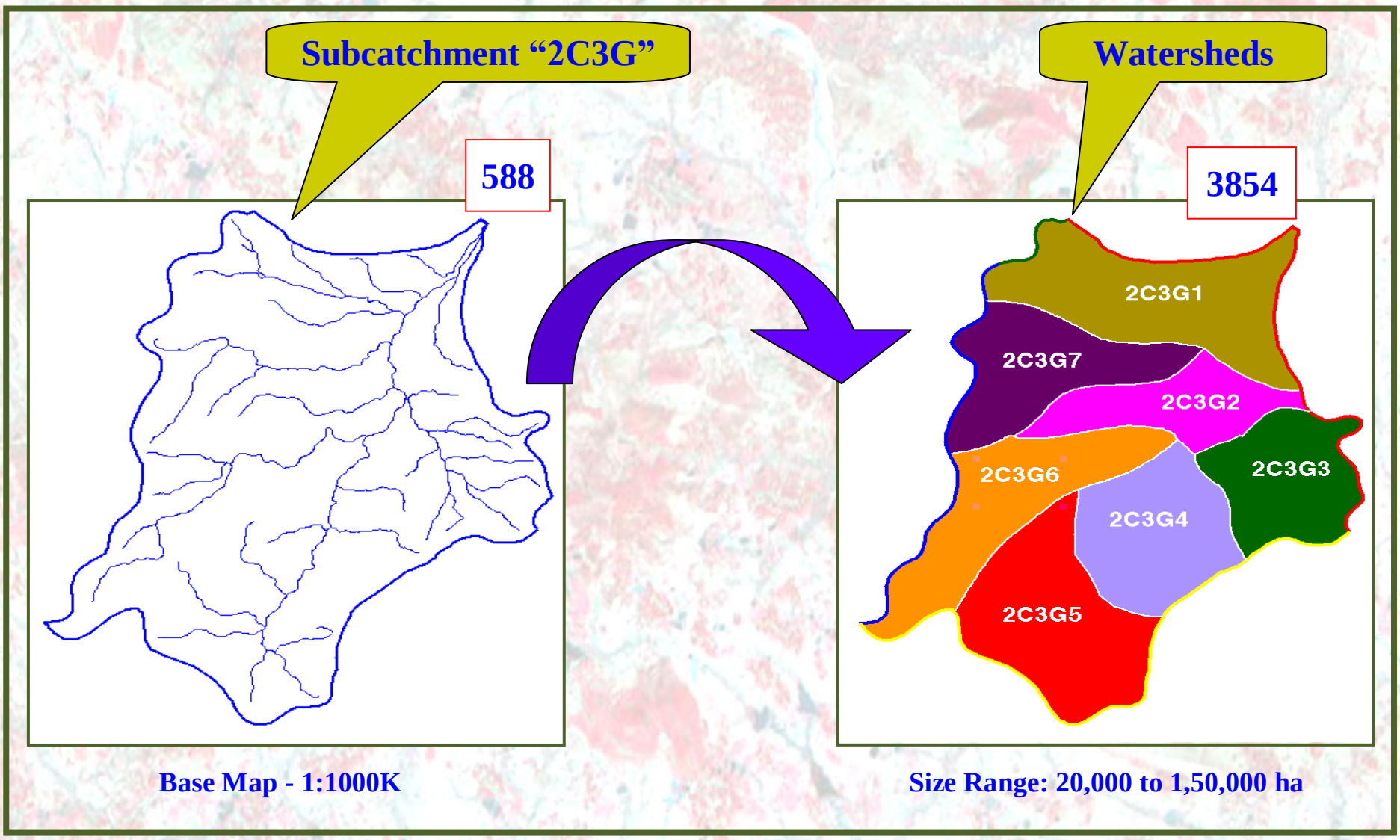

Fig. 5 Delineation of Watersheds from Sub-catchment

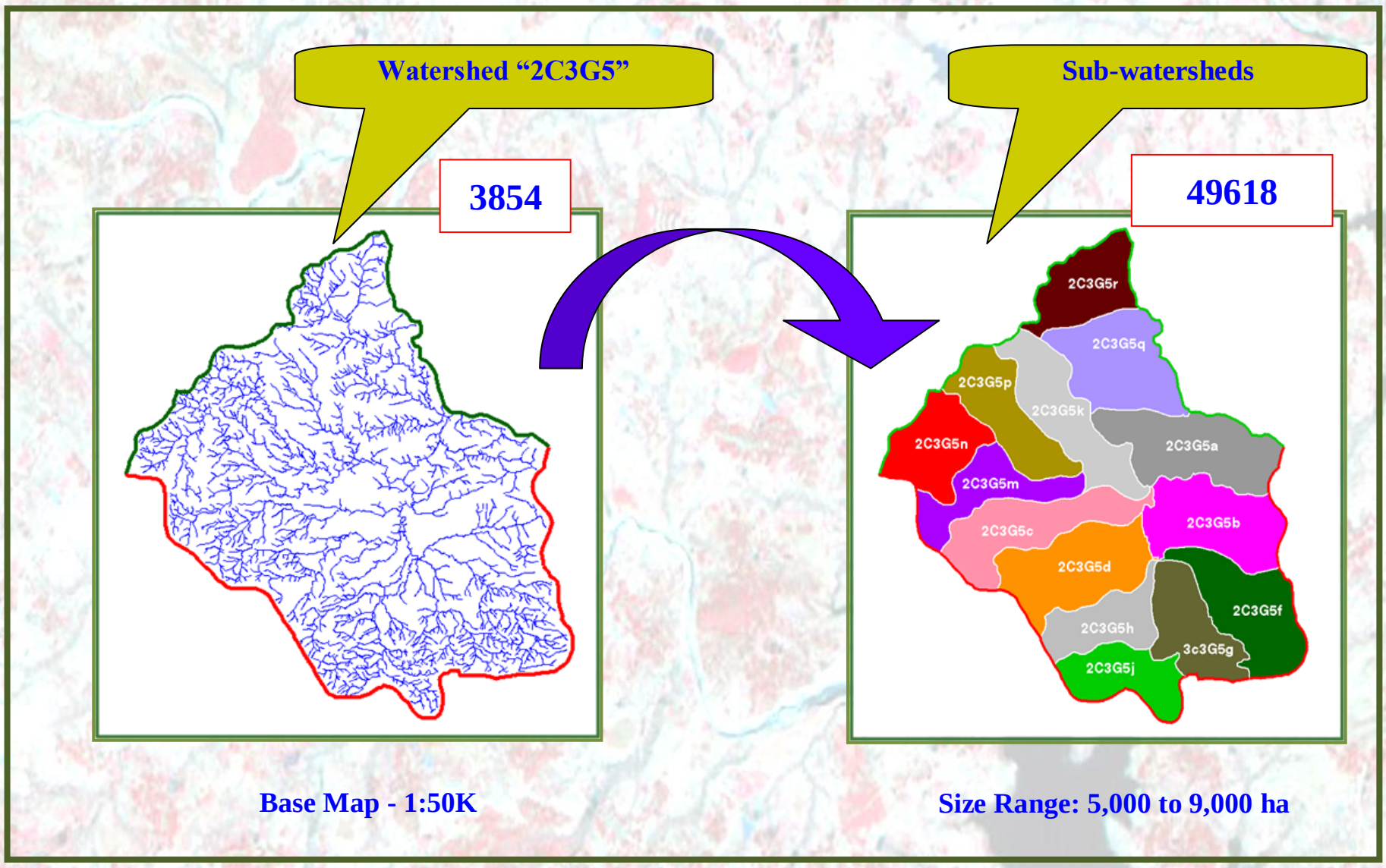

Fig. 6 Delineation of Sub-watershed from Watershed

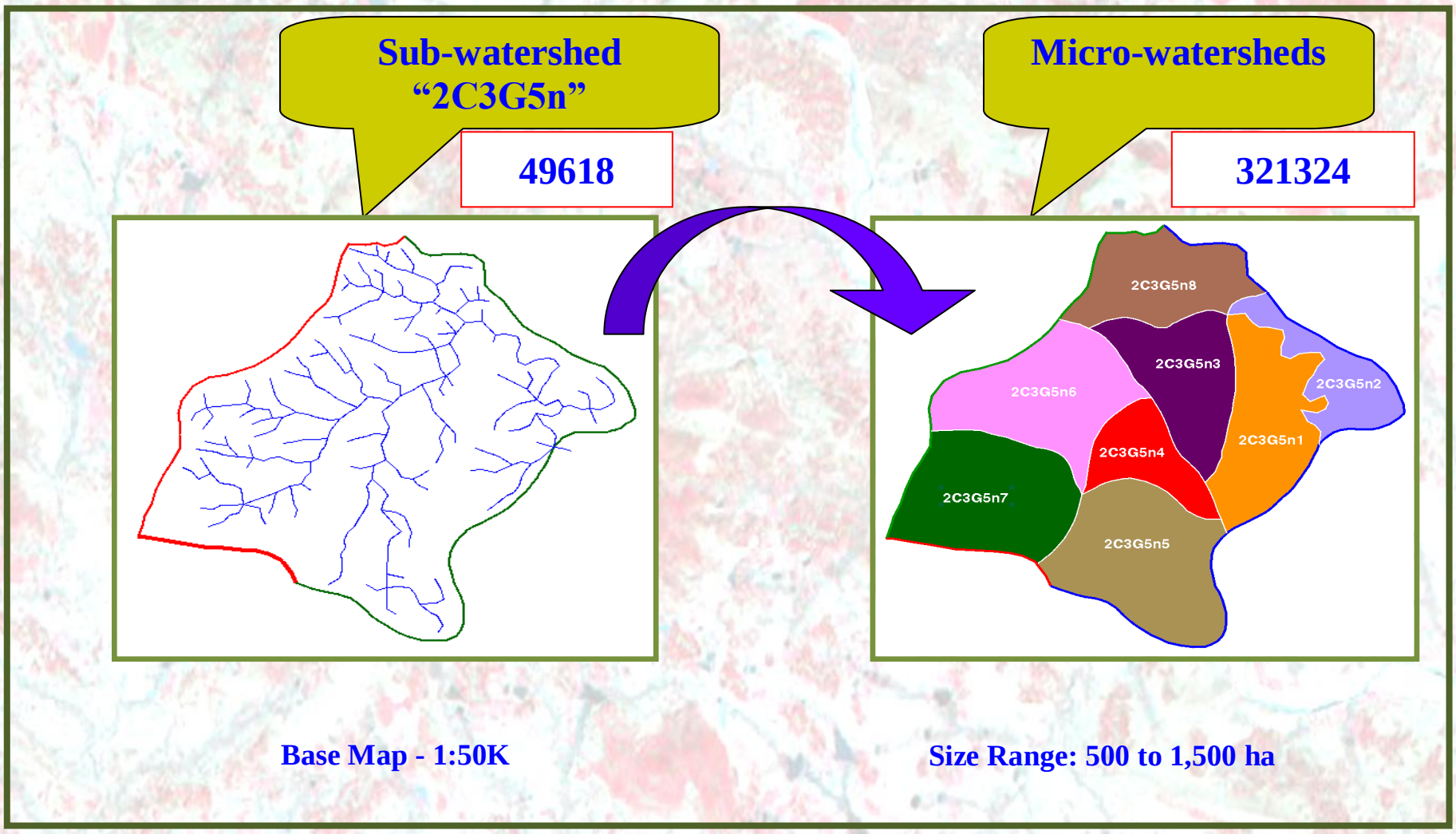

Fig. 7 Delineation of Micro-watershed from Sub-watershed

The average size at different stages of delineation is presented in Table 1.

Table 1 Size Ranges of Different Hydrologic Units

Sl. No	*Hydrologic Units*	*Size Range (ha)*	*Average size (ha)*
1	Water Resources Region	2,70,00,000 – 11,30,00,000	550,00,000
2	Basins	30,00,000 – 300,00,000	95,00,000
3	Catchments	10,00,000 – 50,00,000	30,00,000
4	Subcatchments	2,00,000 – 10,00,000	7,00,000
5	Watersheds	20,000 – 1,50,000	80,000
6	Sub-watershed	5000 – 9000	7000
7	Microwatershed	500 – 1500	1000

Codification System

Alfa-numeric system has been followed to codify the different hydrologic units. The different stages of delineation mentioned above have been codified in a systematic way alternating with Arabic numerals, English capital and small alphabets as follows:

- Water Resources Regions
  1, 2, 3, 4, 5, 6
- Basins
  A, B, C, D, E, F ……
- Catchments
  1, 2, 3, 4 ……
- Sub Catchments
  A, B, C, D, E, F, G ……
- Watersheds
  1, 2, 3, 4, 5, 6……9
- Sub-watersheds
  a, b, c, d,…z (except e, i, o and l)
- Micro-watersheds
  1, 2, 3, 4, 5, 6……9

Thus, at watershed level the code appears as 4D7D1b2 which connotes,

- 4: Region (All drainage flowing into Bay of Bengal except 2 & 3)
- D :Basin (Krishna Basin)
- 7 : Catchment (Upper Bhima Catchment)
- D : Sub-catchment (Nira Sub-catchment)
- 1 : Watershed (Nira & Karai Watershed)
- n : Sub-watershed (Akluj village Area)
- 2 : Micro-watershed (Aklai Devi Temple)

The Micro-watershed Atlas of India (MWAI) prepared on 1: 50K scale contains a total of 588 map plates and 37 map plates designed river-basinwise depicting watershed boundaries and codes.

SALIENT FEATURES

The distribution of Basin under different Water Resource Regions is given in Table 2.

Table 2 Distribution of Basin under different Water Resource Regions

Region	Basin	No. of Catchment	No. of Subcatchment	No. of Watershed	No. of Sub-watershed	No. of Micro-watershed	Area (ha)	Major River
1	1A	2	8	50	768	5729	4942210	Sutlej
	1B	1	4	27	398	2973	2274924	Beas
	1C	1	3	14	211	1487	1190118	Ravi
	1D	1	6	39	500	3663	3036894	Chenab
	1E	1	5	35	308	2233	2947834	Jhelum
	1F	4	21	137	919	6866	13986268	Indus
	1G	2	4	21	-	-	2962355	Ephemeral
Total	**7**	**12**	**51**	**323**	**3104**	**22951**	**31,340,603**	
2	2A	6	41	284	3816	24680	22961525	Left Bank of Ganga
	2B	7	46	332	4823	33166	26754836	Right Bank of Ganga
	2C	7	39	253	3578	24618	20693597	Yamuna
	2D	4	26	171	2638	15908	13728706	Chambal
Total	**4**	**24**	**152**	**1040**	**14855**	**98372**	**84,138,663**	
3	3A	6	25	152	1950	13736	11223330	Right Bank Brahmaputra up to Lohit confluence
	3B	4	17	107	1544	11045	8230932	Left Bank
	3C	3	12	72	1118	7459	5395313	Drainage flowing into Bangladesh
	3D	2	6	38	522	3059	2582201	Drainage flowing into Burma
Total	**4**	**15**	**60**	**369**	**5134**	**35299**	**27,431,776**	
4	4A	2	7	44	459	2544	3801254	Kanyakumari to Cauvery
	4B	4	17	103	1234	6388	8535689	Cauvery
	4C	4	26	172	2178	12816	14286400	Cauvery to Krishna
	4D	8	50	333	4483	23253	27206187	Krishna
	4E	8	57	391	4991	29445	31262619	Godavari
	4F	2	10	58	839	5030	4775953	Godavari to Mahanadi
	4G	3	23	170	2080	12956	14499053	Mahanadi
	4H	3	16	108	1545	9744	8369142	Mahanadi to Ganga WRR
	4I	1	1	8	100	760	690372	Andaman & Nicobar Islands
Total	**9**	**35**	**207**	**1387**	**17909**	**102936**	**113,426,670**	
5	5A	3	11	78	820	4663	5451615	South Western Ghats
	5B	2	12	71	911	5441	5789117	North Western Ghats
	5C	4	15	91	1206	6120	6594182	Tapti
	5D	5	20	130	2066	11476	9768397	Narmada
	5E	3	8	53	842	5017	4025787	Mahi
	5F	2	6	35	591	3442	2753161	Sabarmati
	5G	2	9	58	873	4824	3882431	Southern Kathiawar
	5H	3	11	71	1057	6328	5757182	Drainage of Gulf of Kutch
	5I	1	1	1	3	27	3296	Lakshadweep
Total	**9**	**25**	**93**	**588**	**8369**	**47338**	**44,025,168**	
6	6A	2	13	91	166	9223	9578575	Great Rann of Kutch & Luni
	6B	1	-	-	-	-	5337696	Ephemeral* (Barmer to jaisalmer, Nagaur, Sikar)
	6C	1	-	-	-	-	3036393	Ephemeral* (Jaisalmer, Bikaner, Churu and around)
	6D	2	10	54	81	5205	10770530	Ghaghar and old Saraswati
Total	**4**	**6**	**25**	**147**	**247**	**14428**	**28723194**	
Grand Total	**37**	**117**	**588**	**3854**	**49618**	**321324**	**329,086,073**	

UTILITIES AND APPLICATION OF MICRO-WATERSHED ATLAS OF INDIA

The Micro-Watershed Atlas of India (MWAI) is an important tool for planning, implementation and monitoring of watershed development programmes. The utilities of MWAI, embedded special features, advantages as well as limitations of the watershed atlas been discussed with user Departments and Agencies. User Departments and Agencies have been supplied copies of full or part of the Atlas of their interest along with the compendium of watershed. Some of the utilities and applications that emerge are indicated below:

1. The Micro-watershed Atlas is perhaps the first attempt on National level systematic micro-watershed delineation and codification at 1: 50K scale. It should fulfill the requirement of a framework of micro-watersheds at the micro Level for the whole of the country.
2. A systematic methodology of delineation has been developed following delineation from downstream to upstream approach.
3. The alpha-numeric codification system developed for MWAI which is simple, open and amendable to computerization.
4. The scale of 1:50K makes the MWAI compatible to various thematic maps being prepared on the same scale like, Soil Map of India, Ground Water, Geo-hydrology maps, Forest Map of India etc.
5. The MWAI should provide a good uniform base for development of data bank based on hydrologic unit.
6. The MWAI provides a common basis for various Departments/Agencies involved in development activities based on micro-watershed approach including surface water resources development.
7. The MWAI can form a basis for further micro level delineation and codification of the micro-watershed.
8. The MWAI provides a uniform network of micro-watersheds for runoff and sediment studies and their relationship with catchment characteristics.
9. The additional and ancillary data given in the compendium of micro-watersheds with respect to micro-watershed codes and area (in ha) of micro-watersheds, will be advantageous in working small part of the watershed.
10. Since the new MWAI is digitally produced, it can be uploaded in the website and the user agencies can access the digital maps and data at the click of a mouse.

USERS LIST

The Micro-watershed Atlas of India (MWAI) is already being used by many organizations. List of some users are as below:

1. All State Level Watershed Development Departments and State Soil Survey Organizations.
2. Indian Institute of Technology(IIT)
3. Indian Institute of Management (IIM)
4. Agricultural Universities pan across India
5. Indian Agricultural Research Institute.
6. State Soil and Water Conservation Departments
7. State Remote Sensing Centers
8. Coastal Area Development Authority
9. Centre for Water Resources Development and Management
10. Command Area Development Authorities
11. Geological Survey of India
12. Space Application Centre, Indian Space Research Organisation, Ahmedabad
13. Indian Council of World Affairs for Himalayan Region
14. National Water Development Agency
15. North Eastern Council for the states covered by N.E Region
16. Central Water Commission for Mahanadi Basin
17. Brahmaputra Board for the North Eastern region
18. Indian Photo-Interpretation Institute for Karimnagar district Integrated Resources Survey
19. Managing Director, Hydro-Geo Survey Consultants Pvt. Ltd., Jodhpur.
20. Deputy Director-Cum-Project Director, District Watershed Development Agency, Solan, Government of Himachal Pradesh.
21. Professor & Head (NRM), Aspee College of Horticulture and Forestry, Navsari, Gujarat.
22. Environment Consultant, R. S. Environment Technologies Pvt. Ltd., Gurgaon, Haryana.
23. Assistant Professor, School of Environmental and Earth Sciences, North Maharashtra University, Jalgaon.
24. Assistant Account Officer, Madhya Ganga Division-III, Varanasi. Department of Water Resources, Government of Uttar Pradesh.
25. Deputy Conservator of Forest, Office of Deputy Conservator of Forest, Gurgaon, Government of Haryana.
26. Assistant Professor, Centre on Geo-Informatics Application in Rural Development (CGARD), National Institute of Rural Development, Hyderabad, Government of Telangana.
27. Joint Director, Central Soil & Water Conservation Department of Jammu and Kashmir, Jammu.
28. Department of Agricultural Engineering, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka.
29. Soil Survey Officer, Krishi Bhawan, Civil Lines, Ballia, Department of Agriculture, Uttar Pradesh.
30. ISKCON, Mumbai, Maharashtra.
31. Department of Soil Science, SKUAST-K, Srinagar
32. Mohd. Sajid Idrisi, Consultant, Natural Heritage Division, Lodhi Estate, New Delhi.
33. Soil Conservation Officer, Department of Agriculture, Jhansi, Government of Uttar Pradesh.
34. Director (Technical), Enviro Infra Solutions Pvt. Ltd. Sec-9, Vasundhara, Delhi-NCR, Ghaziabad-201012
35. Chief Engineer-I, M/o Water Resources, River Development and Ganga Rejuvenation, GOI, Brahmaputra Board, Guwahati.
36. Chief Executive Officer & Secretary, West Bengal State Watershed Development Agency (WBSWDA), Kolkata.
37. Deputy Conservator of Forests, Faridabad Forest Division, Government of Haryana.
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REFERENCES

AISLUS (1990) Watershed Atlas of India, All India Soil and Land Use Survey, Dept. of Agriculture and Cooperation, Ministry of Agriculture, Govt. of India, New Delhi.

Anonymous (2009): NASA Satellites Unlock Secret to Northern India's Vanishing Water, Earth Observatory News dated 12th August 2009.

FAO (2010): Water at a Glance: The relationship between water, agriculture, food security and poverty.

Kumar Rajesh, Singh R.D and Sharma K. D (2005): Water Resources of India, Current Science, Vol. 89, No.5.

SLUSI (2012): Watershed Atlas of India, Soil and Land Use Survey of India, Dept. of Agriculture and Cooperation, Ministry of Agriculture, Govt. of India, New Delhi.