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ABSTRACT

Archaeological investigations found the ruins or remains of old irrigation systems, as old as 6th millennium BCE to 250 BCE, in various countries like Mesopotamia and Egypt, Peru, Indus valley in Pakistan. Even water storage systems were built at Girnar, Egypt ancient Persia developed by Qantas in Asia, Middle East and North Africa, Sri Lanka, China and Korea. In India during Vedas time, irrigation was done on small land patches, with anicut on Cauvery and upper river valleys in north India. Water is a prime natural resource and used for multiple uses viz. domestic, irrigation, industry, power generation, navigation etc.. Therefore, water should be used in integrated manner to maximize economic and social welfare. Integrated Water Resources Management's (IWRM) foundation as a global approach was laid at and after the 1992 conferences in Dublin (International Conference on Water and the Environment) and Rio de Janeiro (United Nations conference on Environment and Development, or the Earth Summit). The Global Water Partnership (GWP) was established in 1996 and became the main social carrier of the notion. The GWP promotes IWRM by creating forum at global, regional and national levels, designed to support stakeholders in the practical implementation of IWRM.

In this paper historical review of irrigation development in India and State of Maharashtra has been taken. Water policy and relevance of integrated water resource management is also studied. Maharashtra state is pioneer to implement Integrated State Water Plan (ISWP) in India. This study also reveals assessment of availability of water and equitable distribution of water in the Maharashtra state.

Keywords: water policy, integrate water plan, equitable water, transfer of water.

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I. INTRODUCTION

Water is a prime natural resource. Acknowledging the vital importance of water for human and animal life, for maintaining ecological balance and for economic and developmental activities of all kinds, considering its increasing scarcity, the planning and management of this resource and its optimum, economical, equitable and sustainable use has become a matter of the utmost urgency. Therefore, water should be used in judicial and integrated manner to maximize economic and social welfare. Integrated Water Resources Management's (IWRM) foundation as a global approach was laid at and after the 1992 conferences in Dublin (International Conference on Water and the Environment) and Rio de Janeiro (United Nations conference on Environment and Development, or the Earth Summit). The Global Water Partnership (GWP) was established in 1996 and became the main social carrier of the notion. The GWP promotes IWRM by creating forum at global, regional and national levels, designed to support stakeholders in the practical implementation of IWRM. The distribution of water resources is uneven over a

large part of the State. Such area is therefore, water deficit whereas a small part is bestowed with abundance in water. The water is used for multiple uses as domestic, irrigation, industry, power generation, navigation etc. Water which was once considered as abundant has now, become the scarce and economic resource. The availability of water resources is random, uneven and erratic over most of the part of the State. The State Water Policy formulated by the Government of Maharashtra in 2003 envisages that, the water resources of the State shall be planned, developed, managed with a river basin and sub basin as the unit. This policy states that, the distress in water availability during deficit period shall be shared equitably amongst different sector of water use and also amongst upstream and downstream users.

II. OBJECTIVE

The basic objective of this paper is to take historical review of irrigation development, water policy and implementation of integrated state water plan for judicial and equitable distribution of water in the State of Maharashtra, India.

III. METHODOLOGY

Only secondary data like books, research papers, Reports of high level Committees, Government. Commission's report and websites, Interstate water plan etc. are used for the present research paper.

IV. BACKGROUND

4.1 History of the irrigation development in the world

Archaeological investigations have identified the evidence of irrigation in Mesopotamia and Egypt, as early as the 6th millennium BCE, to support the crops in low rainfall area. In the Zana Valley of the Andes Mountains in Peru, archaeologists found remains of three irrigation canals from 4th millennium BCE to 9th century CE. The Indus valley Civilization in Pakistan and North India (from 2600 BCE) also had an early canal system, with extensive network of canals used for the purpose of irrigation. Even storage systems were developed including the reservoirs built at Girnar in 3000 BCE. There is evidence of ancient Egyptian pharaoh Amenemhet- III in twelfth dynasty (about 1800 BCE) having natural lake to store surplus water due to flooding of Nile, to use during dry season.

In Korea, the world's first water gauge was discovered in 1441 CE, by Jung Young Sil, Engineer, under the active direction of the King Se Jong. This nationwide system was used to measure and collect rainfall for agriculture application. With this instrument, planners and farmers could make better use of the information gathered in the survey.

Ghiyasuddin Tughluq (1220-50) is known to be the first ruler who encouraged digging canals. The Mughal Emperor Firoz Shaha Tughluq got executed one western Yamuna Canal near Delhi in the year 1350. After about 200 years, Emperor Akbar made some developments in the same canal and diverted some water to Hissar district in the year 1568. During the period of Shahajahan one branch canal was taken up to Delhi City through the old existing canal. He has also executed 180 Km long canal from river Ravi to Shalimar garden Lahore. During the year 1730 Emp. Ahmad Shaha got executed the Yamuna right bank canal, which was modified by the British Ruler to irrigate the land of 1.5 Lac Ha in 19th century.

4.2 Irrigation Development In British Era

The concluding years of the nineteenth century saw a horrible famine. This has forced the British Government to undertake at least protective irrigation schemes, though out of reluctance. The work of Ganga canal was also started in the year 1834 and completed in 1854. Cauvery and Godavari canals were also taken up in 1845 the work of Khodshi weir on Krishna River was started in 1870 with canals. The Khadakwalasa dam on Mutha river was completed in 1875. The work of Vihar (1860) Povai and Tulshi (1876) and

Tansa (1883) completed for drinking and industrial water in Mumbai. The dams at Ghodzari, Aswalamendha and Naleshwar in Vidarbha.

4.3 Irrigation Development during Post-Independence Period

India attained Independence in the year 1947 and the Maharashtra State as of today, came into being in 1960. At the time of Independence net irrigated area of India under British Rule which included Pakistan and Bangladesh was 28.2 Million ha, (24.1 %) out of total cultivable area of 116.82 Million ha. After partition, net irrigated area in India and Pakistan was 19.42 Million ha (19.7 %) and 8.82 Million ha (48.1 %), out of the cultivable area of 98.52 Million ha and 18.32 Million ha, respectively. The Plan period, in India commenced from 1951.

Lot of major dams were completed in all parts of the State on rivers like Girna, Mula, Mutha, Deena, Bor, Manar, Koyana, Veer, Purna etc. The irrigation of 3.86 LHa was created in the State of Maharashtra at the time of formation of State on 01.05.1960.

V. STATE WATER POLICY

Water being a State subject, State of Maharashtra had framed its water policy in the year 2003, which was subsequently revised in May, 2011. Since adoption of this policy, significant positive changes have occurred in the water scenario of the State. However, some of the issues and challenges faced by the State water sector still continue and require policy reforms.

Government of India (GOI), also revised its first i. e. of 1987 National Water Policy, and released, the National Water Policy in the year 2012. GOI as per the provision of clause 16.2 of their policy desired, to revise State Water Policy in aligned with the objectives of their policy. Accordingly, the State of Maharashtra has revised the water policy on dated 05.09.2019 with the following objectives.

1. To ensure clean water and sanitation in the State.
2. Judicious and strategic sectoral allocation of water among different water use sectors.
3. Equitable distribution of water and assured access to allocated quota of water.
4. Protection of ecosystems.
5. To protect and enhance water quality of surface as well as ground water.
6. Increasing productivity and efficiency of water use.
7. To make systematic transition from the water resources development mode to an integrated water resources mode with appropriate reforms.

5.1 The State has also achieved following reforms and goals in water Governance.

1. The irrigation potential has been increased from 3.86 LHa (before, 1960-formation of State) to 53.04 LHa on State Sector Projects and 18.01 LHa on Local Sectors schemes totaling to 71.05 LHa till June, 2019. However, the actual utilization of potential is 39.50 LHa on State projects in 2017-2018.
2. Bench marking of water resources projects has been introduced by the WRD (Water Resources Department)as it is very powerful management tool helps in, analyzing and improving performance of water resources projects.
3. Water auditing is the scientific approach to analyze water accounts of the projects. The system performance and water use efficiency can be improved by reducing the losses on overall system.
4. Effectively and successfully managed drinking water supply to most of the cities and towns along with augmented supplies to rural areas.
5. Industrial growth has been accelerated along with the increasing hydro-power capacity from 290 MW to 3684 MW up to March, 2019.
6. The Water User Associations (WUAs) of 5326 numbers have been formed on the project command area introducing Maharashtra

Management of Irrigation Systems by Farmers (MMISF) Act, 2005.

7. The Maharashtra ground water (Development and Management) Act, 2009 has been enacted, to regulate ground water resources of the State through MWRRA.
8. The Maharashtra Water Resources Regulatory Authority (MWRRA) has been established to regulate, facilitate, and ensure judicious, equitable and sustainable management, allocation and utilization of water resources within the State of Maharashtra.

Maharashtra is the first State in the country to introduce such type of Act with quasi-judicial powers for imposing punishment under clause 26 of the MWRRA Act.2005.

5.2 Integrated State Water Plan

As stated in clause 11(f) of powers, functions, and duties of, MWRR Authority, the clearance to irrigation projects can be given, when it is in conformity with Integrated State Water Plan approved by the Govt. committees prescribed under cl.15 &16 of the Act-2005. The clause 15 and 16 of the MWRRA Act, 2005, provides to constitute the State Water Body with Chief Secretary of the State as President, along with 10 other Secretaries of water related departments, as the member of the Board. The Board has to prepare and recommend the draft of Integrated State Water Plan (ISWP) on the basis of basins and sub basin-wise water available and proposed use within State. The clause 16 of MWRRA Act, 2005 also provides to constitute the State Water Council, with the Chief Minister of the State as President, along with 15 other Ministers of Line Departments, as the members of the Council. This Council has to approve the draft ISWP submitted by the State Water Board duly modified, if required within a period of 6 months, with due cognizance of the directives given by the Governor of the State, for the removal of regional imbalance. The plan so approved by the council, shall become the ISWP to be implemented in the State for 5 years, i.e. till next review.

Accordingly, the State Water Council has approved the ISWP for 6 basins in the State of Maharashtra, vide letter dated 07.03.2019. The ISWP covers the status of both surface and ground water of each basin with available surplus water, to be used for deficit basin. The important concept of having minimum 3000 cum of water per hectare of cultivable land for all the sub basins in the State is decided by the SWC while finalizing the ISWP. The water from surplus or abundant sub basins (more than 8000 cubic meter per hectare) is therefore, to be calculated and proposed to be transferred to deficit or highly deficit basins, to make the total available water up to 3000 cubic meter per hectare. As such all the sub-basins of the State, will be brought to the category of Normal water basin, having minimum criteria of 3000 Cum of water per hectare of cultivable land. This is the most important and appropriate decision taken by the SWC for equitable distribution of water in the State.

The State of Maharashtra has erratic, random and uneven distributed rainfall in every basin. The water of 55% is available in West Flowing Rivers Basin over an cultivable area of 6.4% and remaining 45% of water is available on 93.6% area in the State. The ISWP is therefore, very important document to decide the proper and equitable use of available water resources so that, no basin or sub basin will be left in deficit category, because of getting required water from surplus basin in the State of Maharashtra.

5.3 Details of the State of Maharashtra (India)

Maharashtra is the second highest populated, third largest in area and the second most industrialized state in India. The state of Maharashtra came into existence on 1st May 1960.The Geographical location of the Maharashtra is bounded between latitude 16.4 to 22.1 N and longitude 72.6 to 80.9 E. As per 2011 census, the total population of Maharashtra is 112.37 Million, which is 9.29% of the India's population (1210.19 Million). The State has the geographical area of 0.307 Million Sq. Km., which

is about 9.4 per cent of the total area of India. Maharashtra is highly urbanized State, with 45.2% population residing in urban area. The State has about 720 km long coastline along Arabian Sea.The Sahyadri mountain ranges extend almost parallel to western coast line, renowned as western Ghat. The average height of Sahyadri in Maharashtra is 900 m-1000m with higher altitude in the north and diminishes towards south. The State of Maharashtra is getting rain both from the South-West, & North-East monsoon. The average rainfall of the State is approximately 1360mm. The maximum rainfall, about 88 per cent occurs in four months between June to September, about 8 per cent between October to December and remaining 4 per cent after December. Further, rainfall is ranging from 400mm to 6000mm in different parts of the State. It is revealed from this, that there is significant variation in rainfall distribution and its occurrence. The State witnesses frequent drought conditions. Almost 42.5% area of the State is drought prone.

5.3 Basin wise Area Covered by ISWP

The Maharashtra is mainly covered by the basins of rivers Godavari, Krishna, Tapi, Narmada, Mahanadi, and with the Konkan strip of West Flowing Rivers. Thus there are total six basins in the State. The largest basin in the State is Godavari, where as the smallest basin is Mahanadi having less catchment area. The basin wise catchment area in Maharashtra is given in the Table No 1 and Map in Figure No. 1.

Table No.1: The basin wise catchment area in Maharashtra

Sr. No.	River Basin	Total Catchment Area (Sq.km)	Catchment Area in Maharashtra (Sq. km)	% of C.A. in Maharashtra (Col.4/3)	% Of each basin in Maharashtra (Col.4/4)
(1)	(2)	(3)	(4)	(5)	(6)
1	Godavari	3,12,811	1,52,598	48.78%	49.7%
2	Krishna	2,58,948	69,425	26.81%	22.6%
3	Tapi	65,145	52,058	79.06%	17.0%
4	WFR(Kokan)	31,780	31,780	100%	10.3%
5	Narmada	98,976	1,048	1.0%	0.3%
6	Mahanadi	1,41,672	354	0.23%	0.1%
7	Total	9,09,332	3,07,263	33.79%	100%

Source : ISWP Vol. I Page No. 148

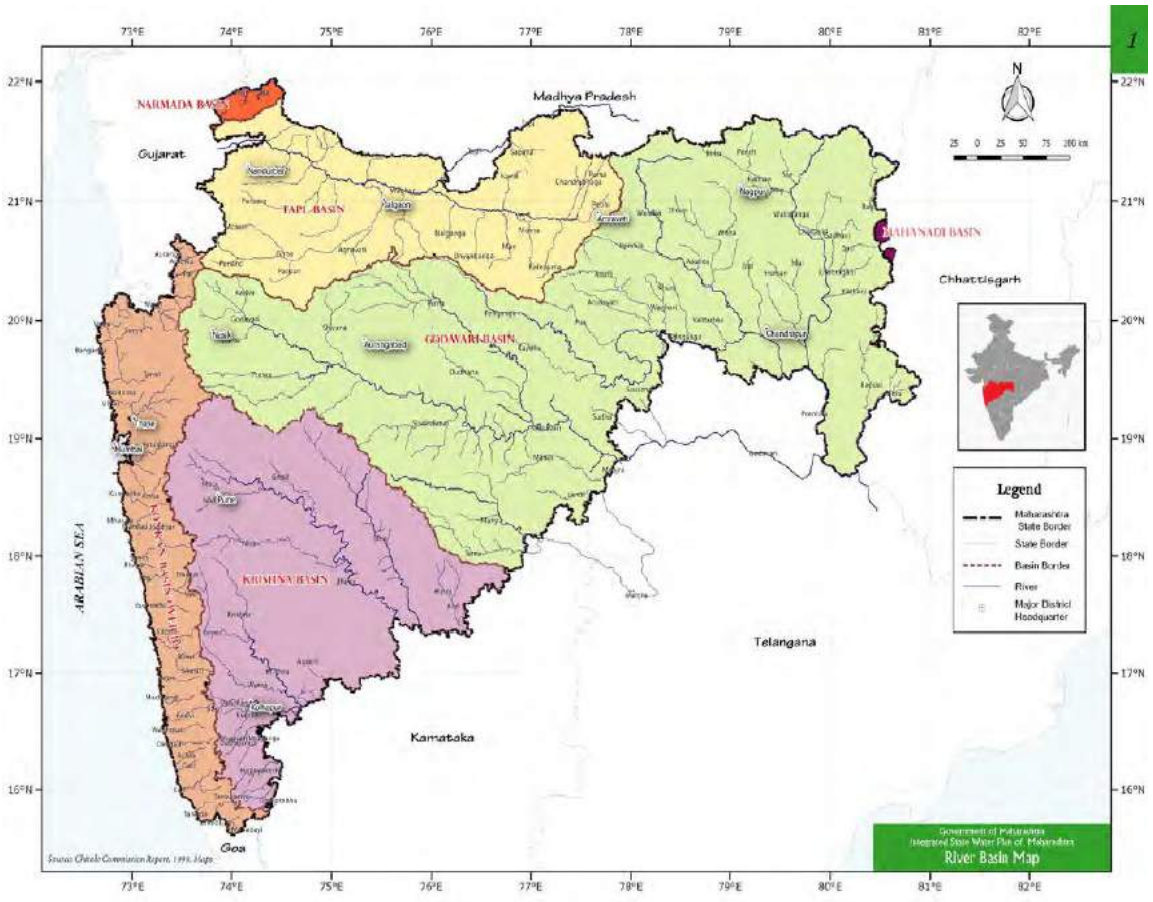

Figure No. 1: Map showing river basins in Maharashtra

According to the Maharashtra Water & Irrigation Commission Report (1999), the ultimate irrigation potential of Maharashtra State has been estimated as, 12.6 Mha of which 8.5 Mha is from surface water and 4.1 Mha from ground water sources. However by the end of June 2019, irrigation potential created is 5.304Mha on State Sector projects and 1.845 M ha (2018) on Local Sector projects. Thus, the total irrigation potential created in Maharashtra; on State and Local Sector schemes is 7.149 Mha. till the end of June 2019.

5.3 Water Resources of the Maharashtra State

The surface water availability in the State of Maharashtra, at Average annual dependability is 202.6 BCM, which consists of 170.3 BCM of surface water and 32.3 BCM of groundwater.. The surface water available at 75% dependable yield is 162.2 BCM, which consists of surface water of 139.6 BCM and the groundwater at 70% net recharge, as per recommendations of State Water Board (SWB) is, 22.6 BCM. The storage capacity created through State Sector water resources projects is 42.85 BCM as on June, 2017

Except the West Flowing Rivers of Konkan, Maharashtra shares water for remaining 5 river basins with the neighbouring State. Various inter-state river water disputes, Tribunal awards / Agreements and decisions on water sharing have limited the use of surface water resources of the State to about 116.2 BCM, of which 64.2 BCM (55%) contribution is alone of West Flowing Rivers basin of Konkan area. However, the cultivable area of this region / basin is very limited (6.4%), comprising of narrow strip of 50 Km between Sahyadri ranges and Arabian sea. Hence, there is a limitation on local use of entire available water. The cultivable area of 5 basins (93.6%) is having only 45% of water resources. Due to this constraints, about 39.8% area of the State lies in deficit or highly deficit category. The

State is experiencing water shortage and recurrent droughts.

5.4 Ground Water

Another prime resource of fresh water is in the sub-surface of the earth, which is infiltrated due to rainfall occurring in that area, is known as ground water. Which is main source of drinking and agriculture use in rural area of Maharashtra. Occurrence and distribution of ground water beneath the earth, varies widely depending on geology, geohydrology, geography and rainfall in that area. Deccan basalt of Maharashtra is one such region of India, which faces acute shortage of ground water due to continues increase demand of groundwater, but as compare to demand, recharge of rainwater is very less, which results lowering of water table every year.

The basin wise surface water and ground water available in the state is shown below, in Table No. 2

Table No. 2: Basin Wise Surface and Ground Water Available in Maharashtra

(Figures in Mcum)

Sr. No.	Basin	Surface water			Ground water		Total water Allowed (SW+GW)
		Av. Avail.	75% Dependable	Allowed by Tribunal	Net Recharge	70% Net recharge	
1.	2.	3.	4.	5.	6.	7.	8. (5+7)
1.	Godavari	51757	38607	29023	17498	12248	41271
2.	Krishna	33710	29299	16562	7817	5479	22041
3.	Tapi	9656	7027	5995	4651	3256	9251
4.	WFR	74739	64218	64218	2264	1583	65801
5.	Narmada	309	308	308	35	25	333
6.	Mahanadi	165	103	103	27	19	122
	Total	170336	139562	116209	32292	22610	138819

5.5 Surface and Ground Water Availability

The water availability, basin wise, as well as, total in the State, has been computed based on natural water availability and restrictions due to various Tribunals, committee Reports, mutual Agreements between the States etc. The information, of basin wise catchment area, metrological set up, overall meteorology of the State, is considered for computation of water availability. The water availability worked out per hectare is deciding strategy for further scope of water resource development in different basins and sub basins. The information regarding allowed surface water in Cubic meter per hectare, and even surface and ground water together, in Cum. per hectare, is shown below in Table No. 3, to decide the category of the basin.

Table No. 3: Basin Wise Water Allotted Per Hectare in Maharashtra

Sr. No.	Basin	Cultivable Area (Lha)	Surface water allocated (Mcum)	Water Available (Cum/Ha)	Total water Sur+GW (Mcum)	Water Available (Cum/Ha)
(1)	(2)	(3)	(4)	(5) (4/3)	(6)	(7)(6/3)
1	Godavari	108.41	29023	2677	41271	3807
2	Krishna	55.98	16562	2959	22041	3937
3	Tapi	34.44	5995	1741	9251	2686
4	WFR	13.63	64218	47115	65801	48277
5	Narmada	0.65	308	4738	333	5123
6	Mahanadi	0.03	103	31647	122	41000
	Total	213.14	116209	5452	138819	6513

Source: ISWP 2019 Page No. 160 and 265

The total surface water available at 75% dependability is 139562 and ground water at 70% net recharge available is, 22610 Mcum. Thus, the total water available for use is 162172 Mcum. Out of this, the total basin-wise surface water allocated and ground water available in the Maharashtra State as shown in above table, is (116209 + 22610) 138819 Mcum.

As stated in the report of Maharashtra Water and Irrigation Commission (1999), the category of basin is decided from the criteria of available water in Cubic meter per hectare of cultivable area is given below, i.e.

i. Highly deficit - 0 to 1500 Cum/ Ha

ii. Deficit- 1500 to 3000 Cum/ Ha

iii. Normal – 3000 to 8000 Cum/ Ha

iv. Surplus water – 8000 to 12000 Cum/ Ha

v. Abundant - above 12000 Cum/ Ha

The above stated criteria, if considered only for Surface Water, then the Godavari, Krishna, and Tapi basins are in the category of Deficit Basins, (col no. 5 in above table) being less water than 3000 Cum. Per hectare.

5.6 Water Resources Development

Water is one of the principal resources essential for human existence and it is required for various purposes such as drinking and domestic water needs, agriculture, industry, hydro and thermal power generation, survival of environment and many others. Availability of water in Godavari/ Krishna/Tapi/Narmada/ West Flowing Rivers (konkan). Mahanadi basins in Maharashtra, for the most part, is from the monsoon rainfall available from June to October which is unevenly distributed over both space and time, whereas water demand for above purposes, except for the agriculture to a certain extent, is mostly evenly distributed over both space and time. The scenario dictates need of development of water resources.

5.6 The Status of Irrigation in the State of Maharashtra.

The basin wise status of the planning, for the irrigation projects completed or to be completed, in the State is considered in the Integrated State Water Plan. The details of the State Sector irrigation projects and Local Sector schemes completed, in progress with the overall position of storage created and its use for the command area of the projects, the overall position of the percentage of irrigation created per hectare of

irrigation and water planned to use per hectare, is analyzed and shown below.

The status of three basins i.e. Godavari, Krishna and Tapi is considered individually but, the remaining small three basins i.e. Narmada, Mahanadi and West Flowing Rivers, area being only 6.7% are considered together and shown in the Table No 4. It is seen from this table that, the water use of 47599 Mcum is done so far, out of the total water of 1,16,209 Mcum allotted to be used for the State. This shows that, only 41% of water is being used in the state after constructing 8297 numbers of projects and proposing the irrigation potential of 74.53 LHa. The average irrigation potential may reach up to 35%, (sr.no 11) in the State. The Krishna basin will reach to 43.1% of irrigation potential as against the other basins will be lying behind the Krishna basin in the state.

Table No.4: Present Irrigation Status of Basins in Maharashtra

Sr. No.	Particulars	Unit	Godavari	Krishna	Tapi	Nar+Maha+ WFR basins	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Sub basins	Nos.	30	5	5	30	70
2	Cultivable Area	LHa	108.42	55.98	34.44	14.29	213.13
3.	Percentage of Cult. Area	%	50.8	26.3	16.2	6.7	100
4.	Surface water allocated	Mcum	29023	16562	5995	64629	116209
5.	Water Allocated per Ha CA(4/2)	Cum	2677	2959	1741	45226	5453
6.	Category of basin	-	Deficit	Deficit	Deficit	Abundant	Normal
7.	Irri. Projects	Nos.	4774	1069	1671	783	8297
8.	Irrigation potential	LHa	37.	24.15	10.07	3.31	74.53
9.	Water use prop.	Mcum	23397	14837	6295	3070	47599
10.	Irrigation per MM^3 (8/9)	Ha	158	162.8	160	170.8	156.60
11.	Percentage of irrigation (8/2)	%	34.1	43.1	29.2	23.2	35
12.	Proposed Target	%	45	45	45	45	45
13.	Difference to achieve (12-11)	%	10.9	01.9	15.8	21.8	10
14.	Addl. water required(13x2/10))	Mcum	7480	653	3401	1824	13358

5.7 Total Surface Water Requirement

Assessment of water balance in each of the basin in the state is most important aspect which will govern water resources management and development in the State. The status of water balance, in each of the basin and the present scenario will help in management of water resources in a better way and will help in deciding the strategy for future development. For arriving water balance in each of the basin and its sub-basin, availability of surface as well as ground water as arrived with restrictions due to the various tribunal awards, reports of the Committees and interstate agreements, have been considered. In addition to natural surface water available, availability due to inter basin and intra-basin water transfer, water from domestic and industrial use has also been considered.

The basin wise total surface water requirement as being computed considering water allotted and its use as explained above. The details of the basin wise water balance are given in the Table No 5 below.

Table No. 5: Basin wise surface water requirement
(Figure in Mcum)

Sr. No.	Basin	Total water requirement for-				Total Use of SW.
		Irri. use	Domestic Use	Industrial Use	Export to othr.basin	
1	2	3	4	5	6	7
1	Godavari	23397	1273	869	242	25781
2	Krishna	14837	318	06	3139	18300
3	Tapi	6295	205	41	00	6541
4	WFR	3065	2262	7802	550	6657
5	Narmada	01	00	00	300	301
6	Mahanadi	04	01	00	00	05
	Total	47599	4059	1696	4231	57585

Total surface water allocated to the State at present is 1,16,209 Mcum, which includes water availability from allocated water, regeneration water, import by way of inter basin transfer. Total planned water use at present is (47599+ 4059+1696+4231), 57585 Mcum. which include use for domestic, industrial, irrigation, ecological purpose and export by way of inter-basin water transfer like hydro water etc. At present(116209-57585) 58,624 Mcum, of water is in balance. Most of the water balance, is in WFR Basin.

But, looking to the equitable water distribution, it is necessary to bring all the basins of the State up to 45% of irrigation potential. The additional water shown at Serial No. 14 of the above table No.4, will have to be transferred from area of surplus basin to deficit basins. Though ample water is available in WFR basin, it is lying at 150-200 Mtrs. elevation. And transfer of water to other basins like Godavari, Krishna and Tapi, the water is to be lifted for about 200 to 400 m. height. Thus it is the costly water. So the quantity of water required for bringing equitable

distribution of irrigation potential up to 45% for all basins in the State, is only to be lifted. The details of basin wise quantity of balance water, are shown below in the Table No. 6.

Table No. 6: Basin wise surface water balance
(Figure in Mcum)

Sr. No.	Basin	Water allotted	Present Water Use	Addl. Use for Equitable Distribution	Total water use (4 + 5)	Balance Water (3-6)
1	2	3	4.	5	6	7
1	Godavari	29023	25781	7480	33261	(-)4238
2	Krishna	16562	18300	653	18953	(-)2391
3	Tapi	5995	6541	3401	9942	(-)3947
4	WFR	64218	6657	1719	8376	55842
5	Narmada	308	301	07	308	-
6	Mahanadi	103	05	98	103	-
	Total	116209	57585	13358	70943	45266

From the above table, the water to be transferred from surplus basin of WFR (Konkan) to the deficit basins for bringing the equitable percentage of irrigation potential, i.e. additional basin wise water required in the State is shown below.

1. Godavari Basin 4238 Mcum (150 TMC)
2. Krishna Basin 2391 Mcum (84 TMC)
3. Tapi Basin 3947 Mcum (140 TMC)

Total water Required 10576 Mcum (374 TMC)

5 .8 Ground Water availability

Ground water is one of the most important natural resources on the Earth. It plays important role in maintenance of economy, environment and standard of living of any society in the State. In the absence of immediate availability of surface water sources, the Rural population of about 75% is dependent upon ground water. It is equally important in river basin management. It has been the primary source of water supply for domestic, agricultural and industrial purposes. It is the single largest and most readily available source of irrigation, and large part of irrigation is depending on the ground water. Nearly 92% area of the State is occupied by the hard rock including basalt(82%) and metamorphic rocks(10%). These rocks have poor ground water yielding (specific yield ranges for 1-3%) capacity. As per the report on Dynamic Ground Water Resources as on 2013-14, out of the total 1531 watersheds of the state, 74 are categorized as over exploited (OE), 04 Critical(CR), 111 Semi Critical(SC), 04 Poor Groundwater Quality and rest 1338 are safe. Groundwater being a common pool resource needs to be managed through participatory approach. Basin wise ground water use is given below, in Table No. 7.

Table No. 7: Basin wise Ground Water Use
(Figure in Mcum)

Sr. No.	Basin	Total water use				Total Use of GW.	Balance
		Total water	Irri. Use	Domestic Use	Industrial Use		
1	2	3	4	5	6	7	8
1	Godavari	12248	7960	464	35	8459	3789
2	Krishna	5479	5142	248	-	5385	94
3	Tapi	3256	2769	187	-	2956	300
4	WFR	1583	241	81	-	322	1261
5	Narmada	25	-	09	-	09	16
6	Mahanadi	19	-	01	01	02	17
	Total	22610	16112	985	36	17133	5477

The overall position of surface and ground water available in the State and its use is shown above. The over all balance position of the surface and ground water is given in the Table No. 8 shown below.

Table No. 8: Abstract for total water balances in the State
Fig in MCum (TMC)

Sr. No.	Particulars	Total allotted / Available Water	Total water use	Balance Water
1.	2.	3.	4.	5.
1.	Surface Water	116209 (4104.9)	70943 (2505.9)	45266 (1599.0)
2.	Ground Water	22610 (798.6)	17133 (605.1)	5477 (193.5)
3.	Total Water	1,38,819 (4903.5)	88,076 (3111.0)	50743 (1792.5)

VI. CONCLUSIONS

While studying the water resources development and management in the State the quantity of basin-wise water available is calculated by considering 75 % dependable yield, the sub-basin wise catchment area and the respective run-off. As the rivers are flowing Inter-States (except WFR) the water allotted by the Tribunals is considered for utilizing in the respective basins of the State. This surface water is proposed to be used for developing irrigation potential and for Non Irrigation use like domestic and industrial purposes. As per the guidelines for sectoral water use suggested by the Maharashtra Water Resources Regulatory Authority (MWRRA) about 25 % storage of dams is proposed for N.I. use and rest of storage is used for developing irrigation potential in the command area of the project.

Looking to the status of developing the irrigation potential (table No.4), in the State of Maharashtra as shown at serial No. 12, all the basins are proposed to reach up to 45% of irrigation potential. Therefore, the additional water of 13358 Mcum is required with net of 10576 Mcum (374

TMC) for increasing the Irrigation Potential, is proposed by transfer of water from WFR basin.

For considering the overall position of water as shown in table No. 8, the total surface water use is 70,943 Mcum (2505.9 TMC) as against the total allocated water of 1,16,209 (140.9 TMC) and the surplus water of 45266 Million cubic meter (1599.0 TMC) is not economical to use, because of heavy lift involved in transfer of water from WFR basin. Similarly, the balance ground water of 5477 Mcum (193.5 TMC) can be used in respective basins. There is no restrictions on the use of ground water within the State boundary. It is therefore, in the interest of the State to extract all the ground water available within the State boundary (as permitted by the State Ground Water Development Act) and use the same for irrigation, domestic purpose, industries etc.

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