

Integrated Urban Water Management for Chandigarh Region, India

Nitish Kumar Sharma¹, Varinder S Kanwar² and Harpreet Singh Kandra³

¹Research Scholar, Civil Engineering Department, Chitkara University, Baddi, India.

²Professor & Vice-Chancellor, Civil Engineering Department, Chitkara University, Baddi, India.

³Lecturer, Department of Civil and Environment Engineering, Federation University, Gippsland, Churchill, Australia.

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Abstract:

“Integrated Urban Water Management” (IUWM) considers all water benefits all the while to decide ideal foundation arrangements. They make numerous advantages, including opening open doors for water reuse. This paper conducts primer evaluation of IUWM plan contextual investigations from Chandigarh. It discovers irregularities between plans comparable to ecological and live capacity targets, and alternative distinguishing proof techniques, and furthermore that numerous IUWM choices perform more terrible than regular water supplies concerning vitality. The most important finding is that the plans do exclude situation arranging and in this manner neglect to consider foundation execution with respect to strength to future vulnerabilities around populace and environmental change. This research paper shows the change needs for IUWM in Chandigarh. The change will involve: 1) stakeholders 2) directive reforms and; 3) human resource development.

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I. INTRODUCTION

The Integrated Urban Water Management (IUWM) alludes to the act of overseeing freshwater, storm water and wastewater as connections inside the asset the board structure, utilizing a urban zone as the unit of the executives. Exercises under the IUWM umbrella are broad and incorporate the accompanying:

- a. Improve water supply and utilization effectiveness.
- b. Guarantee sufficient water quality for drinking water just as wastewater treatment using ESTs and preventive administration rehearses
- c. Improve monetary proficiency of administrations to support activities and ventures for water, wastewater, and tempest water the executives
- d. Use elective water sources, including water, and recovered and treated water
- e. Connect with networks to mirror their requirements and information for water the board
- f. Build up and execute arrangements and systems

to encourage the above exercises

- g. Encourage limit advancement of work force and establishments that are occupied with IUWM.
- The IUWM approach has risen up out of the developing acknowledgment that a coordinated way to deal with water the executives at the urban level offers a pertinent structure for dynamic and solid activity. Urban zones are proper as units of the board, as explicit issues and needs looked by urban communities may rise above the physical and logical limit exemplified by progressively customary units of the executives of catchments and watersheds. The idea incorporates different parts of water the board, including ecological, financial, specialized, political, just as social effects and suggestions.

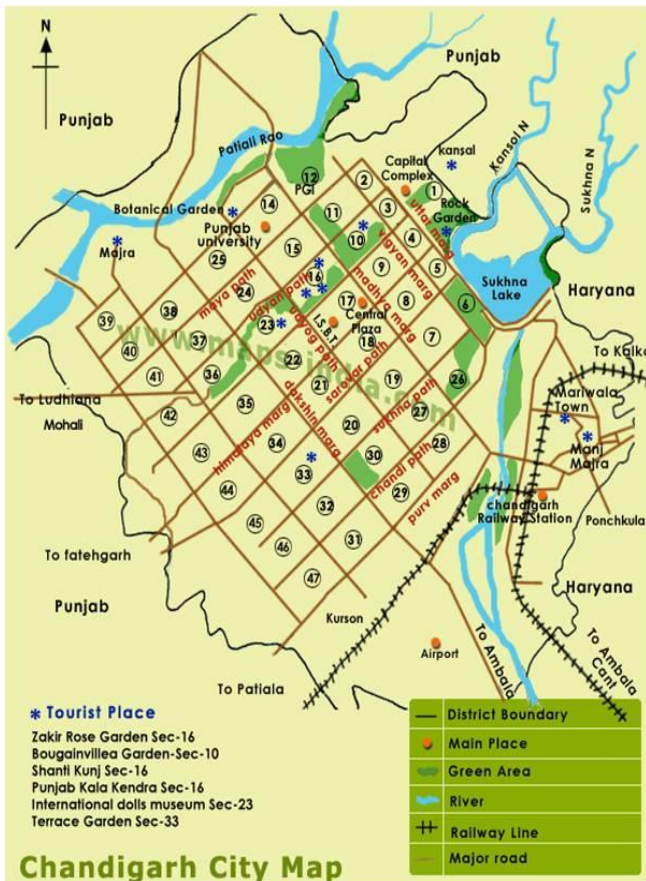


Figure 1.1: Study Area
(Source: Municipal Corporation Chandigarh)

1.1 IUWM SIGNIFICANCE

Access to safe water and satisfactory sanitation are the two basic necessities for human prosperity and poise. Be that as it may, these central needs are not being met, especially in urban regions all through the creating scene.

The urban center is fundamental, as urban communities in creating nations will confront the best test in addressing the requirements for water and sanitation administrations, because of the anticipated increment in populace and urbanization. Anticipated urban populace in Chandigarh in 2030 is 15.60 lakhs.

1.2 IUWM PLANNING METHOD IN CHANDIGARH

An IUWM approach is proposed to be received including different features of the city's advancement regarding the accompanying:

- Sensitive site determination and Eco-delicate Planning,
- Chandigarh to be proclaimed Solar City,
- Environmental neighborly administration of city level administrations, Concepts of REDUCE, RECYCLE AND REUSE of water, strong waste, sewerage,
- Creating Self Sustaining Neighbourhood units as far as Power, Water and Sewage Disposal,
- City's Green - High level of land committed to open spaces, city greens and water bodies,
- Increasing the Green Cover by Mandatory Plantation,
- Comprehensive Mobility Plan for Chandigarh and the Region.
- Efficient Transportation System,
- Eco-accommodating vehicle framework inside locales,
- Promote Bicycle as a Mode of Transportation in the City,
- Construction of Green Buildings/Campuses,
- All future improvements in and around the City delicate to its environs.

1.3 WATER HARVESTING

The interest for water is developing in direct extent to the city's development. Water Harvesting is the best approach to ensure and continue water assets. The Ministry of Urban Development had set up an arrangement for water collecting at city level for Chandigarh. Key discoveries of the venture: -The city taps groundwater from the profound bound springs, which don't get normally energized. Henceforth reviving these springs is an unquestionable requirement. - Tube wells are found all over the city. Reaping water from the treated tempest water and waste water system to energize limited springs through structures up and down the system is a straightforward answer for the city.

Regions reasonable for treated wastewater and tempest water reaping in the city are as per the following:

- Roads and Roundabouts: Recharge along storm

water channels to both energize water just as forestall flooding.

2) All green territories: Recharge where appropriate and store where hydrogeology isn't reasonable. Put away water can be utilized for cultivation. Lakes can be built to reap and utilize water as in Botanical Garden.

3) Institutional regions: Recharge where reasonable and store where hydrogeology isn't appropriate. Put away water can be utilized for cultivation.

4) Commercial zones: Store in underground tanks for non-consumable use.

5) School, universities and strict spots: Store and revive put away water can be utilized for cultivation and other non-consumable employments.

6) Industrial zones and air terminal: Water from rooftop top catchments to be put away and can be utilized for mechanical purposes. Flood of housetop water can be energized. Water from housetops and holders to be reaped away tanks to be utilized for non-consumable purposes.

II. EXPERIMENTAL

This study includes all the tests related to water quality. All the tests were performed in the environment lab.

III. LITERATURE REVIEW

The literature review demonstrated that motivators for recycled water use incorporate urbanization pressures on water supply sources, decreasing regular water assets, and progressively tough wastewater release guidelines. Recycled water is required particularly in dry districts and recycled water extends that target huge water clients are probably going to be increasingly plausible.

Points remembered for the accompanying passages spread the scope of issues required to

evaluate the presentation of double frameworks including: water quality and general wellbeing parts of double water dissemination; involvement in water reuse frameworks; appropriation framework resource and activities the board; and financial matters and institutional game plans of double dispersion frameworks.

M.I. Lvovich (1973) explored water balance study which characterized the pay of water from precipitation and different sources and the misfortune or out progression of water by methods for evapotranspiration which speaks to the joined loss of water from the earth by methods for dissipation and transpiration just as from different sources. The idea of water balance has as of late increased significant significance among the climatologists, Meteorologists, Geographers, Geologists, Hydrologists and from different orders concerned essentially with water issues.

Belinda Hatt et al. (1996) investigate on Integrated Storm water Treatment and Re-use Frameworks - Stock of Australian Practice. Of late signs of ecological corruption, appearing through declining nature of surface and ground water, have been found in various pieces of Australia. For example, the conduits of the Murray Darling Basin and Hawkesbury-Nepean Bowl have debilitated somewhat by virtue of urban water demands and contaminated tempest water discharges (Anderson, 1996). The usage of water resources in various pieces of Australia is moving nearer, and in some urban centers outperforming, the cutoff purposes of viability. Better organized administration of urban water (supply, squander water and tempest water) is required if the water needs of the typical masses are to be satisfied without help rot of nature.

Marsalek J et al. (2006) researched International report on Storm water the board. A universal review of urban tempest water the board (SWM) practice was led for IWA and delivered commitments from 18 nations. The central disclosures of the diagram consolidate away from of a no matter how you look at it excitement for storm water organization and of the affirmation of a far reaching approach to manage

SWM progressing viable urban leakage systems (SUDS). Specific consequences of this rationale consolidate highlight on source controls in SWM, change from standard "hard" structures to green establishments, prerequisites for system backing and rebuilding, course of action of tempest water workplaces (inside greater facilitated water workplaces) with enthusiasm of both open and private regions, and sensible financing through drainage costs instead of general obligations. Further advancement in this field requires focused on innovative work, information sharing, or more each of the, an elevated level of open cooperation in arranging, actualizing and working tempest water the board frameworks.

Fletcher T. D. et al. (2007) investigated storm water gathering beneficial to urban conductor natural streams. Urbanization corrupts the hydrology and water nature of courses. Changes to stream organizations join extended repeat of surface overflow, extended zenith streams and an extension in full scale flood. Meanwhile, water utilize innumerable urban networks is moving nearer, and from time to time outperforming, viable limits. Whirlwind water harvesting can ease a portion of these negative impacts. The results exhibit that using these average gathering circumstances brought stream and water quality back towards their pre-made levels. Once in a while, regardless, harvesting achieved an over-extraction of stream, showing the prerequisite for propelling the social affair system to meet both stockpile and common stream goals. The results show that urban whirlwind water harvesting is a potential framework for achieving both water conservation and normal streams.

Zhuo CHEN et al. (2007) recognized investigation of Sydney's reused water plans. Reused water gives a practical chance to mostly enhance new water supplies just as significantly mitigate ecological burdens. Presently, a large number of reused water plans have been effectively directed in various nations and Sydney is one of the main urban communities, which has paid incredible exertion in applying water recovery, reusing and reuse. This

examination plans to make an extensive investigation of reused water conspires in Sydney for a wide scope of end uses, for example, scene water system, mechanical procedure utilizes and private uses (for example green water system, modern cooling water reuse, can flushing and garments washing and so forth.). For every delegate reused water conspire, this examination researches the included wastewater treatment advancements, the profluent water quality contrasted and indicated rule esteems and open perspectives towards various end employments. In light of these acquired information, multi rules examination (MCA) as far as hazard, money saving advantage, natural and social perspectives can be performed. Therefore, from the diagnostic outcomes, the great possibilities of further extension and investigation of momentum and new end utilizes were recognized towards the incorporated water arranging and the executives. The investigations could likewise help chiefs in making a sound judgment for future reused water ventures.

Daniel Hellstrom et al. (2008) analyzed a structure for systems examination of economical urban water the board. The growing enthusiasm for affordable headway will significantly influence a wide range of urban establishments. Nevertheless, there is a nonattendance of learning of how supportable improvement should be accomplished and how practicality of various particular structures should be overviewed. This paper depicts the structure of a systems examination adventure dealing with the above issues, which focuses on urban water and wastewater systems. The undertaking is a bit of significant national research program in Sweden entitled "Viable Urban Water Administration." This paper suggests sensible markers for the proposed measures. It furthermore contains a compact assessment of the pledge to various common effects and resource utilization of the Swedish urban water structure in association with the impact of Swedish society inside and out, to consider a correct prioritization of the standards.

Joel Stewart et al. (2009) portrayed Assessing supply dangers of reused water allotment

methodologies. A device to assess the inventory perils related with water assignment frameworks used at exuding reuse workplaces is depicted. The device is a month to month water change model and affectability examination. Through assessment of environment records at the Hawkesbury water reuse contrive site (the territory of a solidified profluent and storm water reuse office), it was found that a check of water framework demand took after standard accurate allotments. The surveyed scattering of water framework demand was used as a piece of combination with a water modify model to assess future stockpiling disseminations and along these lines risks of future over-or under-supply circumstances. The apparatus is sensible for use in an operational domain to survey the effect of interest the executives methodologies.

Shiroma et al. (2010) states an Integrated Urban Water Management is a rising methodology for urban water utilities to design and oversee urban water frameworks to limit their effect on the common habitat, to amplify their commitment to social and financial essentialness and to incite generally speaking network improvement. The conspicuous beginning stage for embracing the IUWM approach is the vital arranging stage. Nonetheless, little has been composed on forms that empower utilization of the IUWM way to deal with arranging. Distinguishing this information hole, the Water Research Foundation and the CSIRO, Australia mutually built up a structure to embrace IUWM way to deal with key arranging of urban water frameworks (alluded to as IUWM Planning Framework). This paper talks about standards, drivers and advantages of IUWM approach and gives a diagram of the IUWM Planning Framework.

Arghyam Trust, Bangalore (2010) included intensive study of research grasped wherever all through the world on various pieces of urban water organization by scientists and experts, including yet not confined to urban hydrology, organization of water supply establishment, water resources organization, water quality organization (WQM), groundwater organization, particular and money

related instruments for water demand organization, specific and monetary pieces of spillage decline, environmental and budgetary pieces of wastewater treatment and reuse, storm water organization, limit working for IUWM and genuine and managerial structures. Fundamental data amassing for 27 urban zones/towns and helper data gathering for 300 urban networks/towns was finished, covering all the 16 laid out typologies. Sensible plans of IUWM intercessions were recognized for each typology taking into account the cognizance of how the normal characteristics of these typologies sway the physical, fiscal, institutional, cash related and regular execution of urban water utilities.

Hatt BE et al. (2012) states an incorporated treatment and reusing of tempest water as a survey of Australian practice. With the usage of water moving nearer, and now and again outperforming, the cutoff purposes of supportability in various territories, there is an extending affirmation of the need to utilize storm water for non-consumable essentials, along these lines lessening the solicitation on consumable sources. This paper shows a review of Australian tempest water treatment and reusing practices and what's more a talk of key exercises and perceived data openings. Where possible, proposals for overcoming these data gaps are given. There is an indisputable necessity for the headway of imaginative frameworks for the gathering, treatment and limit of storm water. Existing tempest water reusing practice is far before inquire about, in that there are no advances made especially for storm water reusing.

Casey Furlong et al. (2014) legitimizes The Integrated Urban Water Management (IUWM) worldview, including ideas, for example, water reuse, and Sustainable Urban Drainage Systems, has gotten well known inside Melbourne, and this has made new administration issues. This paper investigates the connection between changing administration structures and IUWM execution. It is discovered that IUWM usage has dominantly been quickened by: a significant dry spell, and actualizing the Office of Living Victoria (OLV) as a general

body. Endeavors by the OLV have expanded between office joint effort, and organized incorporated arranging. Nonetheless, there is still no agreement on what the points of interest of IUWM arranging and framework courses of action ought to really resemble.

Anna Hurlimann et al. (2018) depicted the arrangement of a manageable inventory of water is an undeniably troublesome errand to accomplish in numerous urban situations. This emerges in light of weights identified with populace development and expanded per capita interest for water. Also, environmental change is affecting the regular pattern of water in numerous areas, with a huge effect anticipated for what's to come. Numerous researchers advocate 'supportable urban water the board' (SUWM) as a methodology that can address the main drivers of these difficulties. The paper gives data and devices to help water organizers accomplish SUWM and an all-around adjusted water part and urban condition, in a coordinated, all-encompassing and exhaustive way, to meet future water supply needs. Accomplishing these objectives will require collective exercises over numerous fabricated condition disciplines.

Nitin Bassi et al. (2018) features the institutional change requirements for feasible urban water administration in India. The institutional change will include: 1) one or mix of authoritative change measures involving decentralization, private area interest and, network based administration; 2) order changes and; 3) human asset improvement. The better perspectives will rely on the physical and financial condition, political circumstance and managerial set up that exist in the urban territory. The institutional changes will be all the more so vital for little urban towns where open utilities are given little consideration. All these together can add to improving Indian urban communities arranged for turning away the hazard, in face of fast urbanization, environmental change and water shortage.

IV. MATERIAL AND METHODOLOGY

4.1 VARIOUS METHODS OF CARRYING OUT INTEGRATED URBAN WATER MANAGEMENT

4.1.1 Identify the places in Chandigarh

- a) Sukhna Drain
- b) Patiala ki Rao Drain
- c) STP Diggian Outlet (30MGD)
- d) STP Raipur Khurd Outlet (1.25MGD)
- e) STP Raipur Kalan Outlet (5MGD)
- f) STP Dhanas Outlet (1.6MGD)
- A. Proposed Areas:
 - a) Khuda-ali-sher (1.7MGD)
 - b) Diggian Mohali (15MGD)

4.1.2 Type of data to be collected

- a. Rainfall
- b. Waste water
- c. Canals
- d. Storm water
- e. Tube wells

4.1.3 Sustainable sources of water

- a. By putting away water in tanks or lakes and water bodies.
- b. The system gets over 70% of the all-out precipitation got in the city. Along these lines, this will be a powerful method to enlarge the city's water assets.
- c. Utilization of reused water will be obligatory for all non-consumable utilizations for every single huge structure in every single new turn of events. On the off chance that such water isn't provided by the MC, at that point the structure should set up water treatment plant inside its premises for reuse of waste water.
- d. Develop Green Roofs that diminish the volume and pace of overflow and expel contamination.

4.1.4 To develop a method of using this combined water.

We have considered the project for this study which would be helpful for the water management in the city. It includes Tricity area where we finally

implemented our results and make this thesis helpful for future water crisis and future generation too

V. RESULTS AND DISCUSSION

5.1 WATER QUALITY TESTING RESULTS

Table 1: SUKHNA LAKE (2019)

Sr. No.	Parameters	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
1	pH	-	7.1	7.4	6.9	7.3	8.1	7.6	6.7	7.8	7.4	7.4	6.7	8.2
2	Conductivity	µs/cm	152	137	176	142	218	179	205	178	180	202	224	244
3	DO	mg/l	6.9	8.2	9.7	8.6	6.9	7.2	7.9	8.8	5.1	9.2	7.9	8.7
4	COD	mg/l	24	28	20	32	24	35	40	17	28	36	48	69
5	BOD	mg/l	9	2	3	4	7	5	10	5	2	2	3	3
6	Total Suspended Solid	mg/l	32	35	20	44	15	50	12	30	22	12	19	28
7	TDS	mg/l	115	90	92	98	125	116	163	149	92	93	116	157
8	Turbidity	NTU	2	66	10	40	15	45	10	55	27	28	29	52

Table 2: SUKHNA CHOE/DRAIN (2019)

Sr. No.	Parameters	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
1	pH	-	7.5	7.3	7.5	7.3	7.2	7.3	7.7	7.5	7.4	7.1	7.5	7.4

2	Conductivity	µs/cm	612	794	913	872	1309	624	489	1084	1003	973	1015	428
3	DO	mg/l	2.2	<1	2.1	<1	2.2	2.0	0.7	0.9	0.5	2.0	0.2	2.1
4	COD	mg/l	114	144	157	141	176	148	80	330	248	310	318	307
5	BOD	mg/l	24	46	42	46	50	42	22	203	77	99	132	133
6	Total Suspended Solid	mg/l	26	160	59	170	75	160	32	100	170	62	90	105
7	TDS	mg/l	337	516	449	562	720	405	286	639	496	515	389	274
8	Turbidity	NTU	42	30	80	40	65	75	29	83	47	78	105	190

Table 3: PATIALA KI RAO CHOE/DRAIN (2019)

Sr. No.	Parameters	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
1	pH	-	7.2	7.4	7.5	7.7	7.4	7.7	7.3	7.6	7.7	7.5	7.8	6.6
2	Conductivity	µs/cm	891	800	1049	852	1054	766	1032	644	589	950	1091	1080
3	DO	mg/l	0.1	<1	0.3	<1	0.1	<1	0.7	0.2	0.8	0.5	0.2	0.7
4	COD	mg/l	176	202	186	206	194	212	200	230	298	396	530	610
5	BOD	mg/l	71	75	87	82	72	79	80	58	72	172	298	299
6	Total Suspended Solid	mg/l	97	100	89	100	105	90	110	220	477	277	336	715
7	TDS	mg/l	600	521	570	560	655	498	576	268	304	515	559	519
8	Turbidity	NTU	64	55	80	65	55	70	99	230	495	260	278	380

Table 4: STP RAIPUR KHURD OUTLET (2019)

Sr. No.	Parameters	Unit	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	3	COD	mg/l	128	82	120	89	127	83	100	90	87	148	142	148
1	pH	-	7.4	7.3	7.3	7.2	6.7	7.4	6.9	6.8	7.4	6.8	7.2	7.5	4	BOD	mg/l	32	25	48	27	31	32	26	37	29	49	27	55
2	DO	mg/l	1.9	<1	1.1	<1	1.2	<1	0.8	0.7	0.93	1.1	0.50	0.49	5	TSS	mg/l	38	85	32	75	56	80	49	66	58	25	49	85
3	COD	mg/l	205	82	118	78	136	82	77	81	190	29	30	23	6	Total Nitrogen	mg/l	1.80	3.10	1.36	1.34	1.32	1.37	1.32	1.34	1.34	13.8	13.6	
4	BOD	mg/l	41	24	38	29	45	26	31	47	54	73	82	12															
5	TSS	mg/l	89	50	72	50	57	50	51	85	127	58	97	92															
6	Total Nitrogen	mg/l	1.4	1.5	1.0	7.2	1.2	1.4	1.9	7.1	1.98	1.3	1.8	1.5	a) From table 1 to 5, we have find out the result of water quality performed for different water samples of Chandigarh and from that water sample we calculated BOD, COD, pH, Total solids, DO														

VI. CONCLUSION

a) From table 1 to 5, we have find out the results of water quality performed for different water samples of Chandigarh and from that water samples we calculated BOD, COD, pH, Total solids, DO, Nitrogen content etc.

b) From various samples; we get pH value is 6.7-8.2, DO is 5.7-9.7 mg/l, COD is 17-69 mg/l, BOD is 2-10 mg/l, TSS is 12-50 mg/l, TDS is 90-163 mg/l and Turbidity is 2-66 NTU, for Choe drains, we get pH value is 7.1-7.7, DO is 0.2-2.2 mg/l, COD is 80-330 mg/l, BOD is 22-133 mg/l, TSS is 26-170 mg/l, TDS is 272-720 mg/l and Turbidity is 29-190 NTU and for STP Outlets, we get pH value is 6.7-7.5, DO is 0.4-1.9 mg/l, COD is 77-308 mg/l, BOD is 24-122 mg/l, TSS is 50-127 mg/l and Total Nitrogen is 1.2-14.5 mg/l.

c) From Testing results, we have find out all the samples are normal for the environment point of view and there is no harm to human life also. These results help us in the proper water distribution and IUWM planning of the city.

Table 5: STP DIGGIAN OUTLET (2019)

Sr. No.	Parameters	Unit	Jan.	Feb.	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec.
1	pH	-	7.6	7.5	7.3	7.0	7.4	7.3	7.2	6.3	7.3	7.9	7.1	7.3
2	DO	mg/l	4.9	3.2	4.1	4.2	3.2	4.5	4.3	6.1	4.3	3.6	4.5	4.5

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