Water Sensitive City: Urban Water Management in Pakistan

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Abstract

World Wide Fund for Nature Pakistan (WWF-Pakistan), along with the Australian Government and other partners, have initiated a project titled 'Australia-Pakistan Water Security Initiative (APWASI)' in two marginalized urban communities in the twin cities of Islamabad and Rawalpindi which are facing serious water insecurity. The project focuses on Australia's novel approach to Water Sensitive Cities (WSC) which includes integrated and holistic management of urban water with a diverse aim to increase the city's livability and sustainability. Under APWASI, a mix of nature-based solutions and engineered infrastructure along with other locally suitable interventions have been adopted to improve access to safe water and sanitation services, create spaces that harvest, conserve, clean and recycle water to meet its water demand and other water security challenges and ensure community resilience to climate change. Through the implementation of APWASI, since its inception, detailed baseline assessments have been conducted to assess the water security issues in urban settings of Pakistan along with technical / feasibility studies including climate change and rainfall-runoff modeling, estimation of water demand, groundwater assessments and aquifer studies. Also, through the implementation of interventions at ground level around 24,400 people now have improved access to safe drinking water through the installation of six water filtration units. A total of 650 rainwater harvesting systems have been installed at household level with an estimated 53,000 m^3 of non-potable water conserved/reused per year. Approximately 3,638 m^3 of water has been replenished/recharged to the groundwater aquifer through the installation of 23 groundwater recharge interventions. 4,380 m^3 of greywater has been reused for non-potable purposes through the installation of three ablution water reuse systems. Three green spaces and four rain gardens have been developed to improve liveability and reduce urban heat, thus enhancing community resilience to climate change. Initiatives like APWASI hold prime importance for cities and communities of developing countries facing serious water insecurities and adverse impacts of climate change. Therefore, there is an utmost need for adopting, upscaling and mainstreaming such initiatives for sustainable, liveable and resilient cities.

Key Words: Water Sensitive City Approach; Water Sensitive Urban Design; Australia Pakistan Water Security Initiative, Nature Based Solutions (Nbs), Rainwater Harvesting

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Jan, M.Q., Shafique, M., Raynolds, R.G., Jan, I.U., Ghani, M. (Eds.) Indus Water System. National Centre of Excellence in Geology, University of Peshawar & Pakistan Academy of Sciences, Islamabad, Pakistan (2024) weblink: http://nceg.uop.edu.pk/books/IWS.html

1. Introduction

Pakistan is a water-stressed country with an average per capita water availability of less than 1,000 m^3 per annum (GOP, 2018). Water availability is expected to be less predictable with frequent floods and droughts becoming more common, thereby adding to climate change-induced vulnerabilities of millions of poor people affected by the lack of water, food and energy security.

According to the National Pakistan Population and Housing Census 2017, 75.6 million people in Pakistan live in urban settings. Many of these people are living below the poverty line, with poor or no access to basic facilities, such as clean drinking water, sanitation, health, education and other public infrastructure. During the Covid 19 pandemic, for example, while the instructions for containing the spread of the virus may sound fairly simple, like ‘washing your hands for 20 seconds with soap multiple times a day, it is not a feasible task for the majority of those residing in Pakistan's disadvantaged settlements that are water deprived. These communities are affected by the unavailability of adequate water supplies and sanitation facilities. It is in this context that this project was conceived and project sites selected.

- Rawalpindi and Islamabad Capital Territory, often referred to as the “twin cities”; the city sites for this project, are currently facing some serious water-related issues such as:
- Inadequate availability and access to clean drinking water in disadvantaged communities
- Degrading groundwater quality and lack of efficient urban and groundwater management
- Substandard and low-capacity rainwater disposal and stormwater drainage systems
- Improper wastewater management and lack of sanitation in disadvantaged communities
- Poor urban planning, weak governance, and institutional arrangements for effective integrated water resources management with inclusion of all segments of society
- Lack of data (surface, groundwater and climate change) for peri-urban areas.

Women, children and the elderly are the most vulnerable, especially in urban disadvantaged neighborhoods where access to safe water supplies, sanitation facilities and associated wastewater disposal remains inadequate. The key needs identified for disadvantaged settlements are to promote an integrated approach to replenish and develop groundwater resources and treat wastewater through cost-effective means while ensuring people have access to clean water and sanitation. Furthermore, the maximizing potential of urban areas requires institutionalizing mechanisms of coordination, planning and accountability at all levels with all stakeholders.

Moreover, the urban settings in Pakistan are facing adverse impacts of climate change in terms of an increase in temperature and a decrease in precipitation, which results in water insecurities in the region. Results from numerous studies have indicated continuous warming trends in the 21st century under the intermediate GHG emissions scenario. The combined effect of rising spring temperatures and a decrease in rainfall could result in more droughts-like conditions before monsoon. These conditions, along with increasing summer/autumn rainfall, can pave the way for a higher probability of flooding once the monsoon starts (Banister, 2011).

2. Water Sensitive City definitions and approaches

As the 21st century commenced, there has been a rapid increase in urbanization and industrial development. With the increase in urban developments and associated activities, the risk of adverse impacts on the land and water environment has also grown. Under such circumstances, there is a big challenge to urban communities in establishing resilience to the adverse impacts of population growth, impacts of climate change and sustainable management of resources. At the same time due to current infrastructure and management-related issues, the urban water crisis is posing a big challenge to urban communities. Therefore, there is a need to transform a conventional water supply city into a water-sensitive city. A water-sensitive city depicts best practices of urban water management through a holistic approach to urban water planning and design to acquire multiple benefits and services of the total urban water cycle. A water-sensitive city may include water supply and drainage security, solutions for public health issues, water bodies health protection, flood protection, recreational services along long-term sustainable environmental benefits. The core of water water-sensitive city approach lies in water-sensitive urban design which aims to provide due importance to water in the urban design process through the primary integration of engineering, environmental and societal services within ~~an~~ urban community. Though water water-sensitive city is a novel concept for urban localities of underdeveloped countries, it may play an important role in identifying a safer future through sustainable development and long-term benefits (Wong and Brown, 2009).

3. South Asia Water Security Initiative

The South Asia Water Security Initiative (SAWASI) by the Australian Government was established to improve access to safe water and sanitation services for disadvantaged communities in South Asian cities. The objective of the program is to strengthen South Asian city-level water governance and undertake investments that provide urban water services support to disadvantaged communities (particularly women and girls) to access reliable and safe water and sanitation services.

Pakistan recognizes that Australia has exceptional expertise in water management and enjoys a reputation as a trusted provider of neutral water expertise. Contextually, the Australia-Pakistan Water Security Initiative (APWASI), a grant from the Department of Foreign Affairs and Trade (DFAT) Australia to Pakistan aims at drawing on a broad range of Australian good practices on Water Sensitive Urban Design (WSUD)/Water Sensitive Cities approach (WSCs). To embark on an ambitious journey towards becoming water sensitive, Pakistan needs to demonstrate the approach at a small scale first and then develop pathways towards replication and upscaling at the city level. For this, APWASI aims at planning and implementing activities around holistic water management at two disadvantaged communities in each of the twin cities to demonstrate the WSCs approach.

4. Vision and Objective of APWASI

The objectives for the APWASI are as follows:

a. Improve access to safe water and sanitation services for two targeted disadvantaged communities, particularly vulnerable groups through demonstration of low-cost Nature Based Solutions (NbS) [site-specific interventions (WSC approach)].

b. Ensure community resilience to climate change and other water-related shocks through the mix of locally suitable interventions.

c. Build capacity and awareness of key stakeholders on urban water management, as well as educate and sensitize local communities, youth and other users about water use and conservation.

5. Site Selection of Process

WWF-Pakistan and APWASI consortium partners employed a needs-based approach for demonstration site selection (Fig. 1) where meetings with pertinent stakeholders were held. These consultative meetings aimed to identify disadvantaged communities in Islamabad and Rawalpindi that held the most potential to demonstrate interventions drawn from the full suite of WSCs technologies and approaches. WWF-Pakistan conducted virtual and face-to-face meetings and consultative sessions with relevant public and private stakeholders, including the Capital Development Authority (CDA), Water and Sanitation Agency (WASA), and local potential communities of Islamabad and Rawalpindi.

As part of the consultation, on-ground surveys and face-to-face interviews were conducted at the identified sites to assess community needs, identify existing operational and non-operational government schemes, and to seek community endorsement and participation in this initiative.

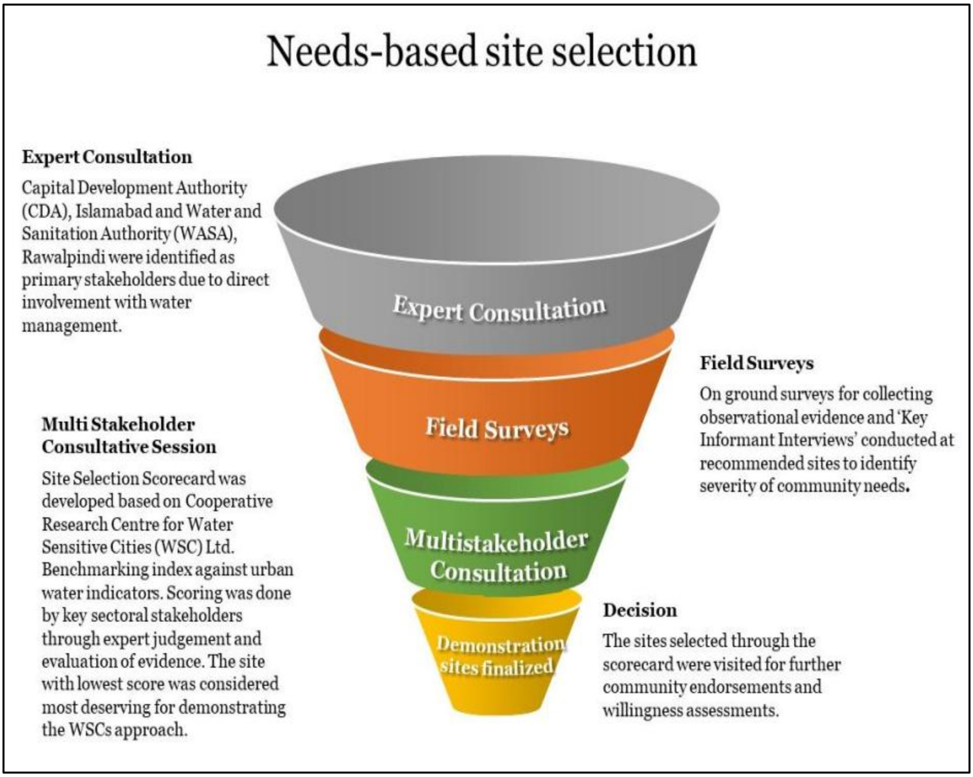

Figure 1. Need-based site selection process.

5.1. *Steps for site selection*

5.1.1. Initial stakeholder/expert consultation, At the initial stage, project stakeholders from the governance sector were engaged. The MoWR requested nominations and focal points were appointed from CDA Islamabad and WASA Rawalpindi. CDA had recommended sites based on the understanding that those four are model villages/towns and have the potential to demonstrate approaches due to their planned nature as well as existing water management issues. WASA Rawalpindi recommended sites based on lack of access, affordability and poor quality of water. The recommendations were based on CDA' and WASA's expert judgment and deep understanding of all areas in both the cities.

5.1.2. Field visits. After the identification of potential sites, primary visits were carried out at all sites. Using the visits, preliminary data were collected for geographic, environmental, and socio-economic parameters of the potential sites to help understand the on-ground dynamics. Site profiles were developed from all the collected observational evidence and interviews. Afterwards, a scorecard was developed to establish corresponding WSCs project site selection criteria for Islamabad and Rawalpindi. The scorecard used for the process was adopted from the Cooperative Research Centre for WSCs Benchmarking Index (Water Sensitive Cities Index).

5.1.3. Demonstration site selection consultation workshop, A consultation workshop for APWASI demonstration site selection was organized in Islamabad and Rawalpindi. The objective of the workshop was to finalize the APWASI demonstration sites for the WSCs approach application in Pakistan. Multiple Stakeholder experts, climate experts, researchers and academicians were consulted in the workshop. As an outcome of the consultation and scoring exercise, Farash Town from Islamabad and UC Kalial from Rawalpindi were shortlisted as the project sites for the WSCs approach demonstration.

5.1.4. Community willingness assessment. Post consultation, shortlisted project communities were visited and consulted for endorsement and assessment of participation willingness through face-to-face meetings. Due to the absence of a proper public water supply system, improper sewage management, poor hygiene conditions (and associated health concerns), and the interest of the community in the project implementation, Farash Town and James Town were selected as the most suitable sites for WSCs approach implementation in Rawalpindi.

5.1.4.1. Locality /site description. Farash Town (Islamabad) was established in 1992 when displaced inhabitants were resettled from various areas of Islamabad.

Farash Town falls under Zone IV of Islamabad and is situated at the Southeast of Islamabad city. Topographical details such as public spaces, including schools, mosques, parks and open areas, have also been identified and marked. The map also shows that many undeveloped/ open spaces exist in patches specifically at the center of the project site. Several natural drains are spread throughout the Town which receives stormwater as well as raw sewage from the nearby areas. The topography of the area is a combination of plains and slopes; however, the overall stormwater drains into a nearby nullah/stream.

James Town (Rawalpindi) is located in Union Council Kalial of Tehsil Rawalpindi, situated alongside the Adiala Road. Compared to Farash Town, James Town has undulating topography and the majority of the households are located on slopes. Furthermore, James Town is not administratively planned and there is an absence of infrastructure including water supply, sewage network, storm water system and proper roads.

6. Baseline Assessments

Focus Group Discussions and Key Informant Interviews

To better understand the neighborhood context, community engagement has been planned at a range of levels. Local knowledge and the experiences of community members are a rich source of information to assess priorities and needs. The community engagement process was initiated through key informant interviews. At later stages, this will expand to focus group discussions and visioning workshops to develop a holistic and integrated water vision for both communities. Through extensive community engagement, it was highlighted that residents of both communities have been facing serious water crises in terms of availability and management. Water shortage and its unavailability have placed financial as well as social stress on both communities.

7. Socio-Economic Assessment

This survey was backed by the idea that water use and issues are significantly influenced by socio-economic status alongside broader systems and infrastructures, technologies and biophysical influences. The findings from the socio-economic survey highlight that both Farash Town and James Town are highly disadvantaged in terms of income levels, water availability and affordability. The communities are marginalized and are low-income, which jeopardizes their quality of life. At the same time, households are facing water scarcity due to poor urban water management and the unavailability of public water supply. This further aggravates the situation by putting water-related financial stress on the communities already living with limited resources, thus making them more vulnerable.

The socioeconomic survey was conducted from 300 households from a total household number of 3000 in Farash Town (10% of the total household numbers). The result, demonstrated in Fig. 2, shows that 53.8% of the households have 2 to 7 residents, and 36.5% of households have 8 to 13 residents in each household. Thus, it has been demonstrated that the household members in the maximum number of houses are from 2 to 7, similar to any low-middle income household members in Pakistan.

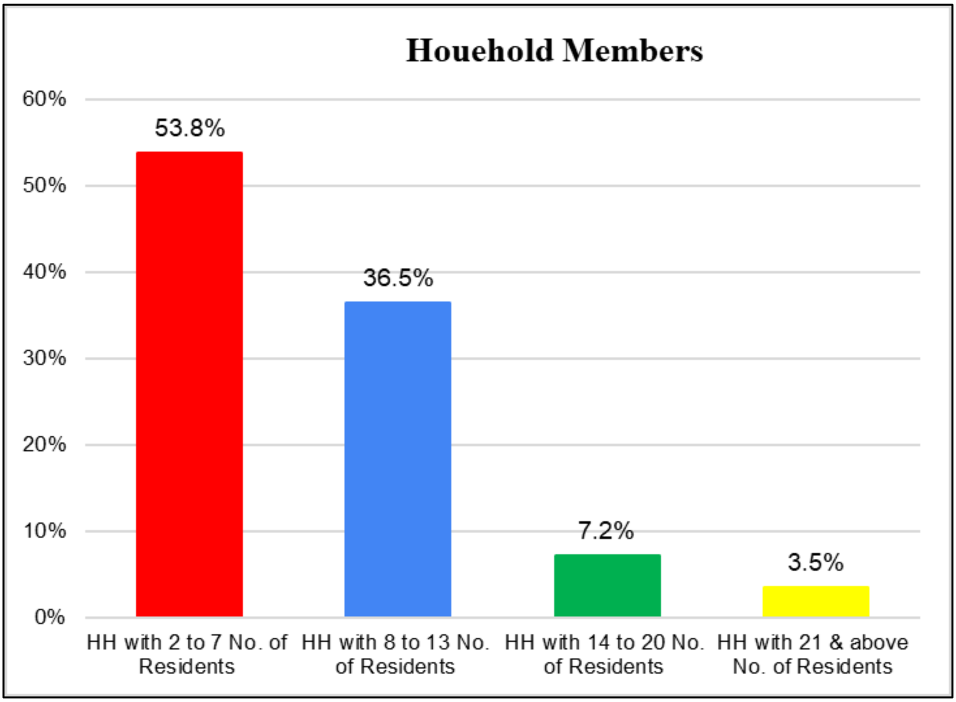

Figure 2. Proportion of household members in Farash Town.

Fig. 3 demonstrates the availability of public water supply within the community and the results show that 89% of the total and representative households have no public water supply and only 11% of households receive water from public water supply sources.

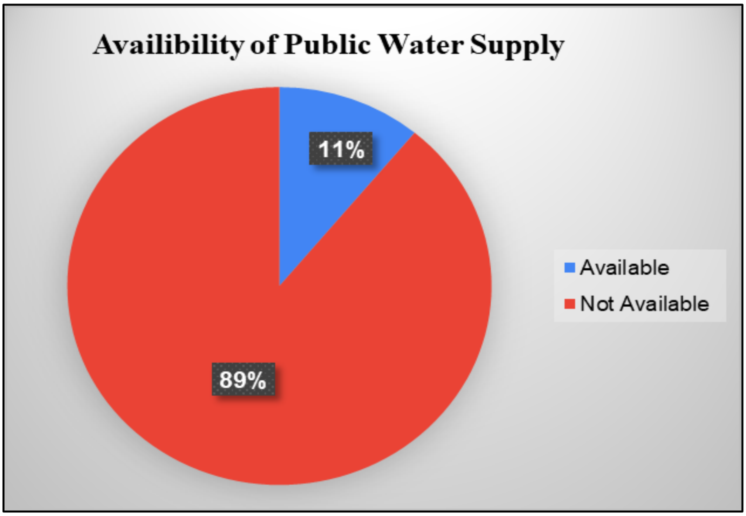

Figure 3. Availability of public water supply in Farash Town.

Fig. 4 demonstrates major sources of water used by the community to cater to their daily requirement. It is shown that 80% of the households are relying on their own boring and usage of groundwater, 45.5% of the population rely on public / private tankers, and 25.7% meet their need through both bore water and tankers.

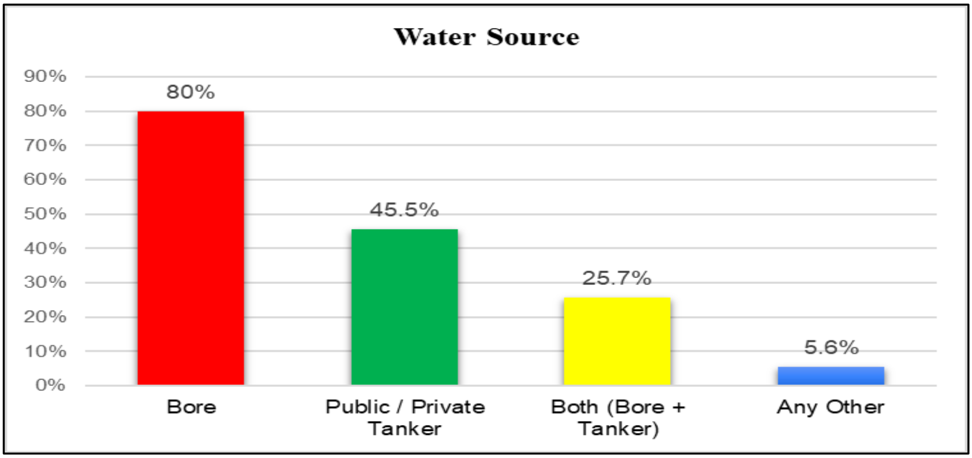

Figure 4. Source of water by usage in Farash Town.

Similarly, James Town is facing a serious water crisis with non-availability of both surface and groundwater supplies. Fig. 5 shows the percentage of residents in the area, with 61.3% of the population living for 10 years. Similarly, 32.5% of the population is living in James Town for a period of 11 to 20 years, while only 6.3% of the population is living in the area for 21 to 35 years. The maximum number of residents have their own house in James Town.

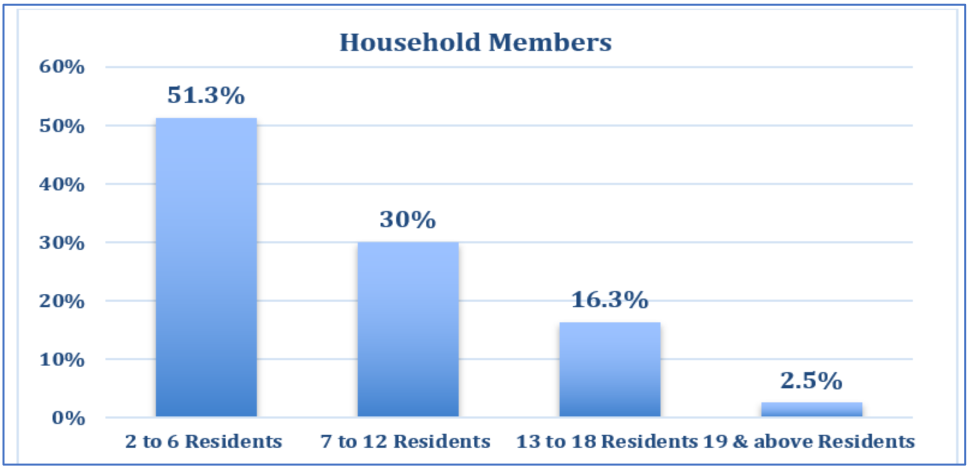

Figure 5. Proportion of household members in James Town.

The household survey (Fig. 6) revealed that there is not a single source of public water supplies in the area. Fig. 6. demonstrates that 100% of the population lacks the availability of public water supplies, thus creating serious water problems in the area.

Figure 6. Availability of public water supply in James Town.

Fig. 7. shows the major sources of water that are used by the inhabitants. It is demonstrated that only 15 % of the households in the area rely on bore water which is mostly brackish, whereas, around 86 % of the total households surveyed depend

on private tankers to meet their daily water demand, thus rendering serious financial pressure on the residents. There also is no guarantee about the cleanliness of the supplied water.

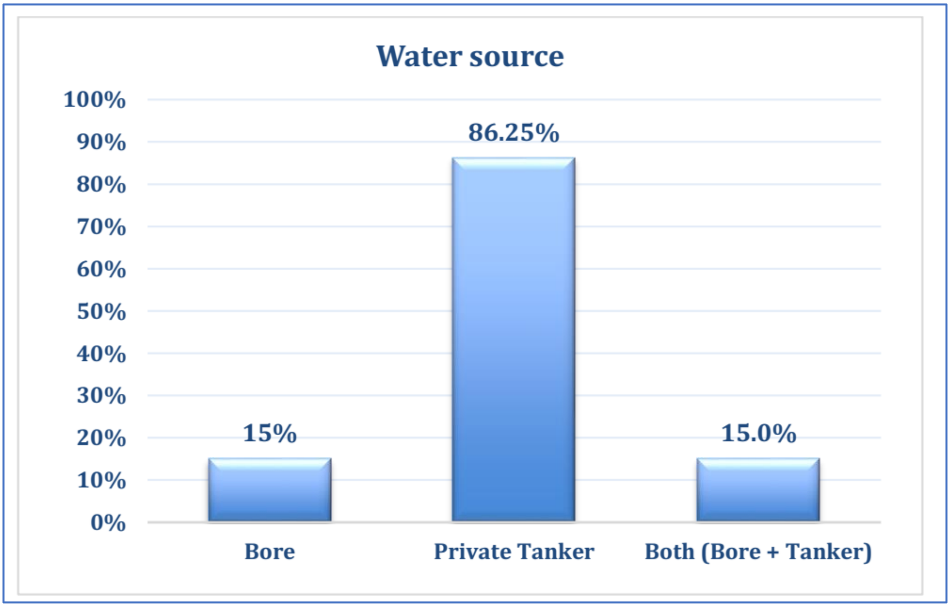

Figure 7. Water Source by Usage in James Town.

8. Flood Assessment

Based upon the seasonal precipitation intensity and its associated vulnerability in the upper region of the country, a flood assessment survey was conducted with households of both communities to assess flood-related vulnerability. The flood assessment survey mainly comprises information regarding urban flooding after an event of rainfall, any losses or disturbance in livelihood during intense rains, damages, access to clean drinking water during floods, information regarding flood preparedness and, mitigation and adaptation measures.

The survey shows that the majority of the streets of Farash Town have a stormwater network and natural drains/nullahs flowing across the area. The region falls under sub-tropical climatic zones which receive heavy rainfall in the monsoon season, mainly from July to August. However, the inhabitants are not affected by rains or floods mainly due to its topographical location and natural streams/nullahs flowing beside Farash Town and their discharge in the Soan River.

The situation of James Town (Rawalpindi) regarding floods and rainfall is the same as Farash Town. The physical survey of James Town exhibits undulating terrain with slopes which play an important role in maintaining the natural flow during a rainfall event. However, being marginalized, the poor livelihood of the inhabitants, lack of stormwater/drainage system and poor infrastructure play-a vital role in affecting the people's lifestyles during an intense rainfall event.

9. Water Insecurity

The water insecurity survey at the household level was conducted in both Farash Town and James Town. A questionnaire to assess and analyze water insecurity was established based on the Household Water Insecurity Experiences (HWISE) scale. The analysis of data and related results show that the communities are deprived of their basic needs due to high-risk water insecurity and both areas fall under the water insecure domain with an average of 25 on the HWISE scale.

It can be noted from Fig. 8a, showing the proportion of insecure households, that 88% of the households have a HWISE score of ≥ 12 and only 12 % of the households have a HWISE score of < 12 with an average score of 23.43 from all households. Thus there is a serious water insecurity in Farash Town.

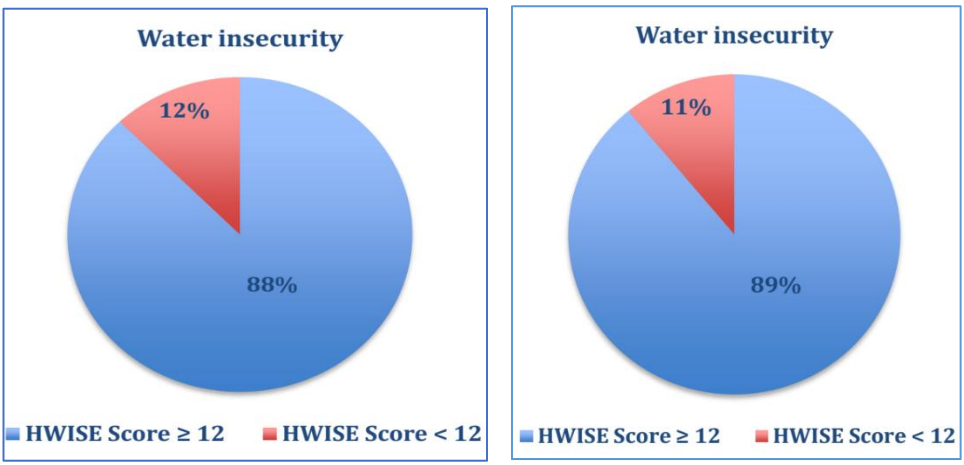

Figure 8. Water Insecurity Scales, a) Farash Town, b) James Town.

Fig. 8b shows the result of a HWISE scale survey to assess the water insecurity level prevailing within James Town. It is demonstrated that 89% of the households have HWISE ≥ 12 and only 11% of the households have HWISE < 12, with an average score of 23.81 from all households, thus exhibiting serious water insecurity issues in James Town as well.

10. Estimation of Water Demand

From the field visits and surveys, it was found that there are no public water supply schemes in the two communities. Both are facing severe water shortages mainly due to the unavailability of public water supplies and depletion of groundwater tables due to excessive abstraction and lack of efficient drinking water facilities. Under such circumstances, the inhabitants are facing serious financial stress due to the consumption of a huge quantity of water purchased through private water tankers. There is also no reliable information on the quality of the supplied water. The estimation of the existing water demand of both communities was a huge challenge due to the unavailability of information on water supply and usage of water from numerous sources. In this context, the project team conducted a baseline survey to calculate water demand for both communities.

To find out the water demand in Farash Town and James Town, a household survey was conducted by the project team. A questionnaire was established which mainly comprises questions regarding water source, storage type, volume/capacity of a storage reservoir, use of non-potable water, and information regarding drinking water collection and usage mechanisms. Primary data were collected by the aforementioned household survey which acquired desired information from 300 households in Farash Town and 80 households in James Town, i.e., approximately 10% of the population. The data quality of the survey has been ensured by checking of enumeration work by the supervisors in the field. Teams at the project office, field/site coordinator, and field officers thoroughly reviewed and edited the questionnaire to check inconsistencies or omissions (WWF Pakistan, 2021).

Non-potable water demand was calculated based on the information gathered from the household survey. The demand was calculated based on non-potable water source, storage capacity and day/time required to completely use the stored water. Fig. 9 shows non-potable water demand per household in l/day. It has been demonstrated that the average non-potable water demand per household in Farash Town is 587.71 l/day, with a maximum demand of 2000 l/day based on household members, water source and consumption (WWF Pakistan, 2021).

Fig. 10 shows non-potable water demand per capita in Farash Town. It has been analyzed that the average demand for households is 87.7 LPCD, with a maximum demand of 300 LPCD (liters per capita per day). From the results, it is estimated that in Farash Town per capita is less in comparison to other urban areas in Pakistan, which may be attributed to a change in consumption patterns over time due to the water-stressed situation here (WWF Pakistan, 2021).

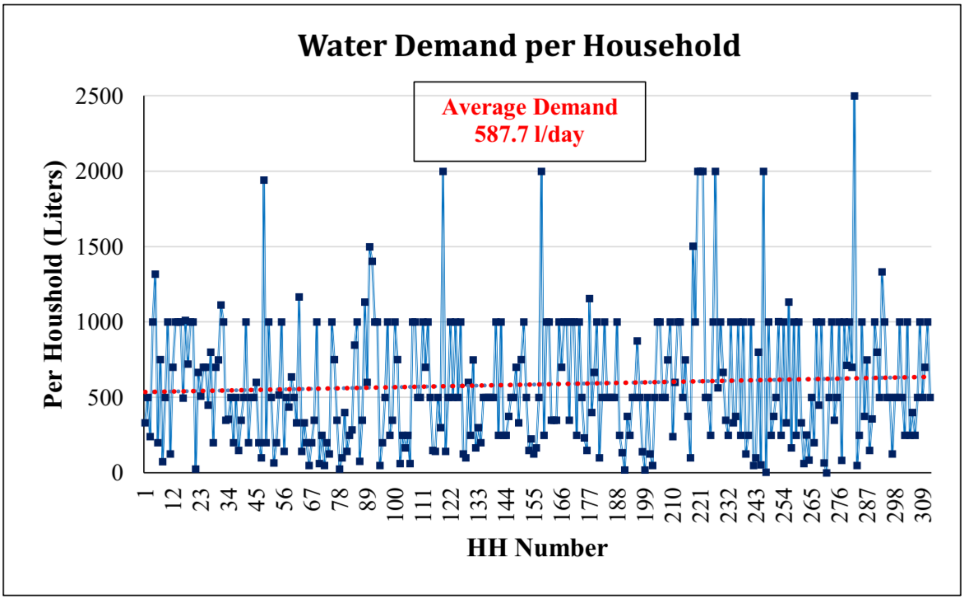

Figure 9. Water Demand per household in Farash Town.

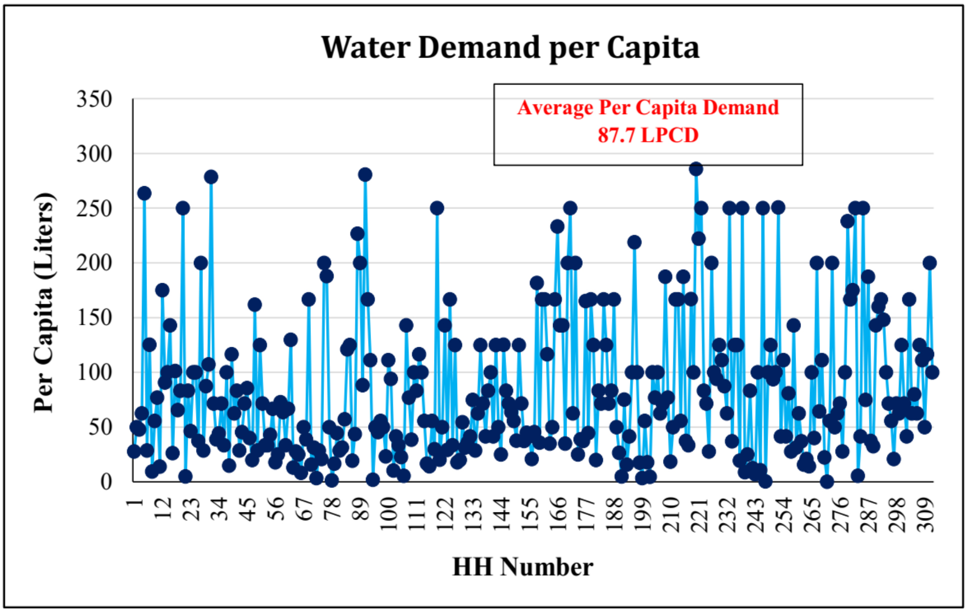

Figure 10. Per capita water demand in Farash Town.

Similarly, Fig. 11 shows non-potable water demand at household and per-person levels in James Town. It has been demonstrated that the average non-potable water demand per household in James Town is 492.1 l/day, with maximum demand ranging from 1400 to 1600 l/day based on household members, water source and consumption. Fig. 12 shows that the average per capita demand in James Town is 62,4 LPCD with a maximum value ranging from 100 to 140 l/d, which is comparatively less than Farash Town as the community is extremely low income (WWF Pakistan, 2021).

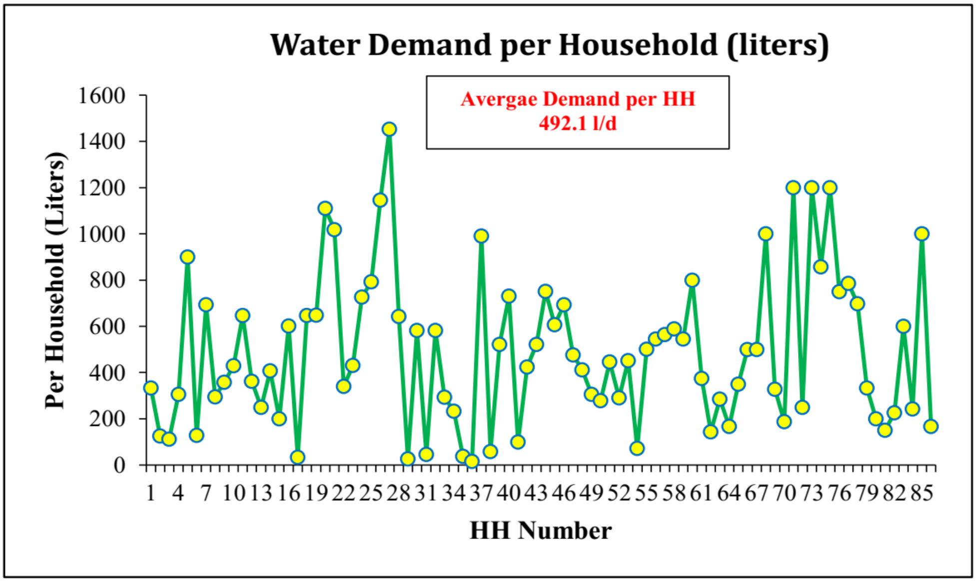

Figure 11. Water Demand per household in James Town.

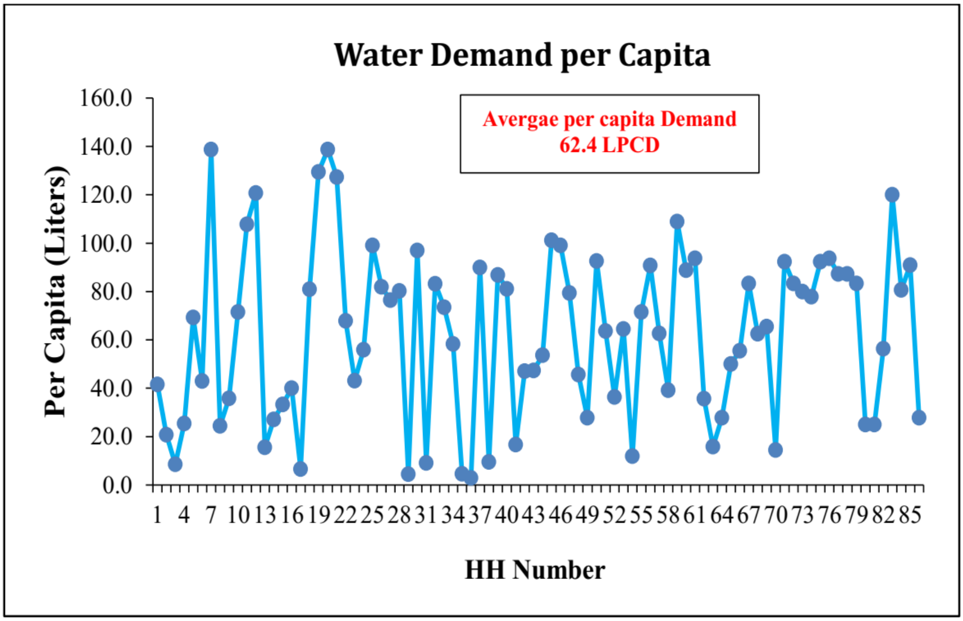

Figure 12. Per capita water demand in James Town.

11. Climate Change Impact Assessment

The future climate change assessment of Farash Town in Islamabad, James Town in Rawalpindi and the greater Pindi basin are carried out based on the multi-model ensemble of five best-performing statistical down models called global climate models. The results in Fig. 13 and 14 show the continuous warming trends in the 21st century for both sites under the intermediate GHG emissions scenario (SSP2-4.5) and very high GHG emissions scenario (SSP5-8.5). The temperature anomalies show strong trends in winter and spring as compared to changes in summer and autumn temperatures. The mean winter (spring) temperature is projected to increase by 3.0°C (2.7°C) under SSP2-4.5 and by 4.7°C (5.0°C) under SSP5-8.5 scenarios for the study area. These temperature changes will cause shorter winters, more heat days and tropical nights, longer vegetation periods and higher evapotranspiration, resulting in significantly increased water demand for domestic needs, agriculture and forestry (Security, no date).

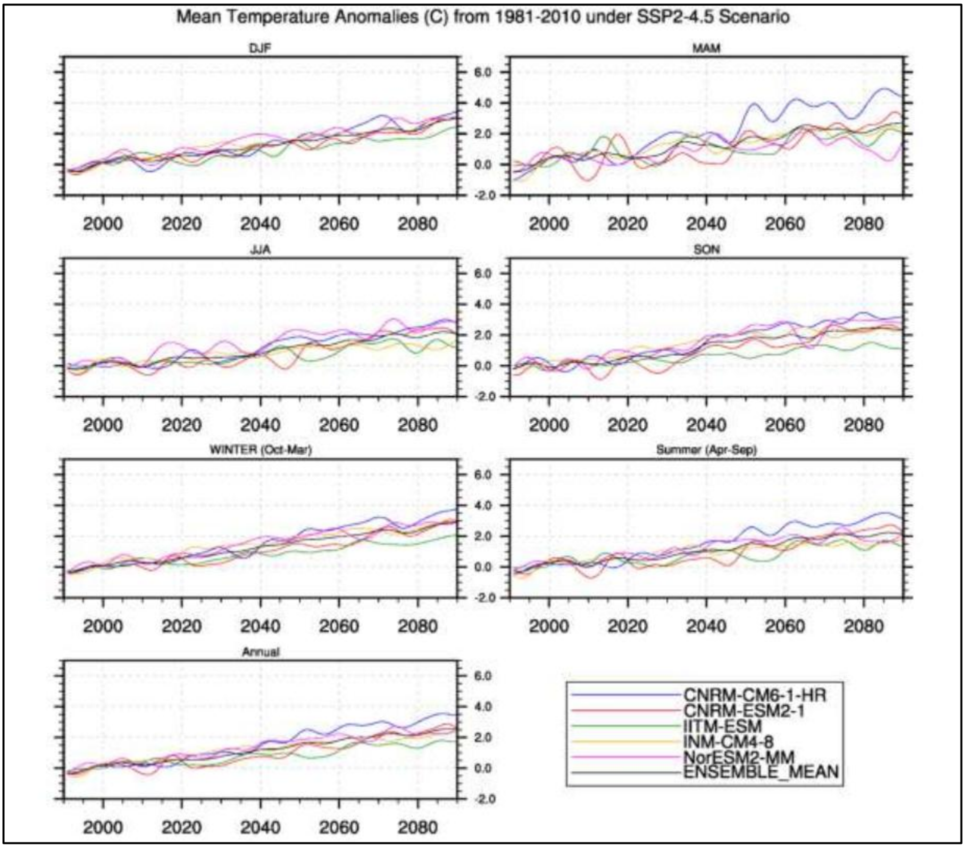

Figure 13. Average annual and seasonal anomalies of daily mean temperature (in °C) from the base period.

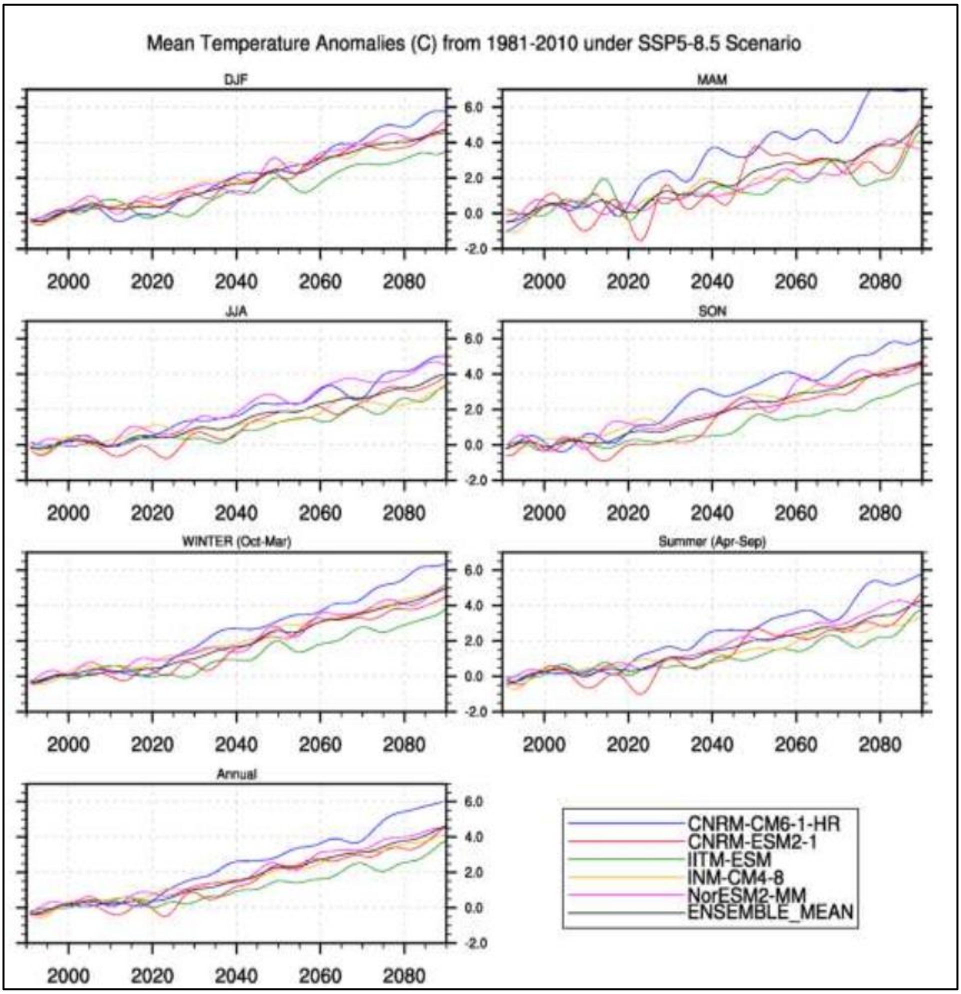

Figure 14. Average annual and seasonal anomalies of daily mean temperature (in °C) from the base period.

Results from Fig. 15 and 16 show that the mean annual precipitation of the region is projected to increase by about 10% under SSP2-4.5 and about 38% under SSP5-8.5 by the end of the century. However, on a seasonal scale, winter and spring (pre-monsoon) rainfall shows decreasing trends whereas precipitation in summer and fall shows a significant increase throughout the 21st century. The combined effect of rising spring temperatures and a decrease in pre-monsoon rainfall could result in more drought-like conditions before monsoon. This condition, along with increasing summer/autumn rainfall, can pave the way to a higher probability of flooding once the monsoon starts (similar to the year 2022 flooding). The changes in precipitation also manifest themselves in the form of climatic extremes, for example, the result shows an increase in RX1day (highest one-day precipitation amount), very high precipitation (R95P) and extremely high precipitation (R99P), hinting towards more extreme climatic events in future (Security, no date).

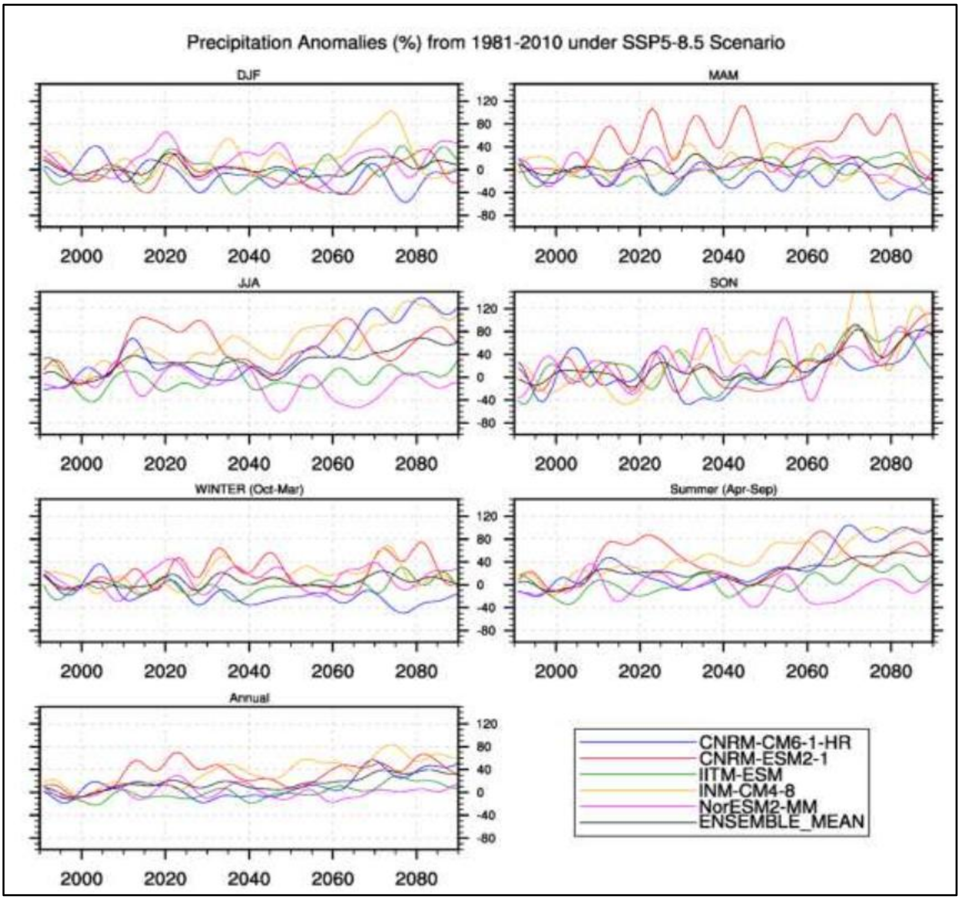

Figure 15. Average annual and seasonal anomalies of daily precipitation (in percentage change) from the base period.

The analysis has also shown potential solutions and recommendations to cope with the challenges of adverse impacts of climate change in the Pindi basin, a few of which are as follows;

1. Improved climate change projections, analyses, and assessments
2. Land-use planning that promotes plantation and development of agricultural land

3. Development of environmental research and information networks among the institutions to exchange related climatological data about flood risks and mitigation planning
4. Align research goals with long-term policies to build synergies across multiple objectives

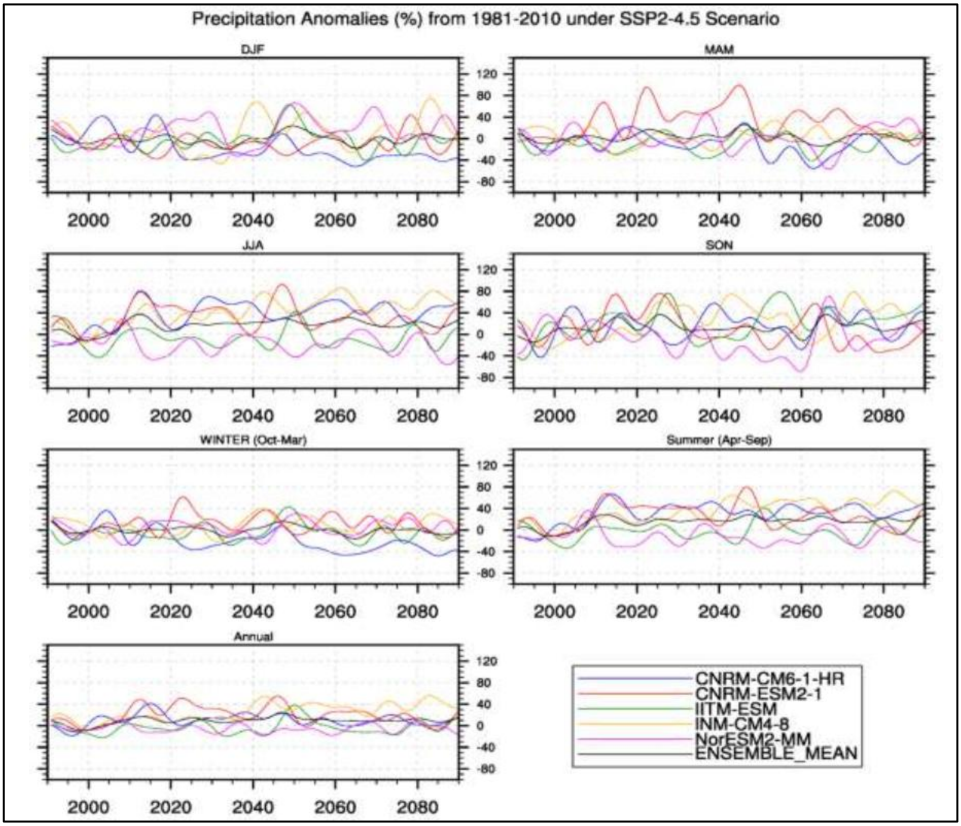

Figure 16. Average annual and seasonal anomalies of daily precipitation (in percentage change) from the base period.

12. Rainfall-Runoff Models and Trend Analysis

In baseline assessments rainfall trend analysis and development of rainfall-runoff models have been developed to guide the potential and design of rain and stormwater harvesting systems. The rainfall trend is the considerable variation in the spatial and temporal patterns of rainfall. In other words, the trend can be described as the general tendency, movement, or direction and pattern in which rainfall takes place. Rainfall trend analysis is the understanding of the area's rainfall trends and variability that helps to identify the associated uncertainties related to water. It also gives an idea about the rainfall event intensity for specific return periods.

The key Findings of the analysis are as follows;

- The analysis, including the 2021 rainfall data, has shown no significant change. Except for the mean rainfall in October 2021, the rainfall is within the currently observed bandwidth.
- The rainfall for Islamabad and Rawalpindi is very similar
- The mean annual rainfall for both sites is approximately 1,300 mm
- Both sites have a strong seasonal pattern. Approximately 60% of the mean annual rainfall is during the monsoon season from July to September
- The driest period is from October to December, with 39-, 16- and 30-mm monthly rainfall, respectively
- On average, it rains 80 days a year, and the most prolonged duration without rainfall on record has been observed with 89 days in 2017
- The largest rainfall for Islamabad was recorded on 24 July 2001 at 592 mm, and for Rawalpindi was recorded on 05 September 2014 at 298 mm
- Small and moderate events account for the majority of the rainfall. Daily rainfall smaller than 36 mm accounts for 50%, and smaller than 73 mm for 80% of the total annual rainfall
- Some 55% of the landcover in Farash Town and 50% in James Town are impervious
- For both sites, the roof area contributes significantly to the impervious area with 35% in Farash and 29% in James Town
- Both sites can harvest significant amounts of rain and stormwater during the monsoon season and can provide for most of the water demand during the wet season. However, the system will run dry for 80% of the year
- Reuse of treated waste or greywater provides a significant climate-independent water source and should be explored for non-potable use

13. Programme Outputs Based Upon Baseline Assessments

13.1. Formation of Community-Based Organization (CBO)

APWASI, being people-powered and people-centered, believes that community involvement, in the planning and execution of any intervention leads to more effective and equitable development. Therefore, the team planned on channeling all of the community-based interventions through CBOs. In one critical respect, this practice is well founded: CBOs often emerge and play an important role in providing public goods and in resolving collective action problems when formal institutions are deficient. For this very reason, the primary function of CBOs is kept as support towards implementing the Water Sensitive City vision through robust community engagement. Gender inclusiveness was ensured by the project team as a one-to-one male-to-female ratio was kept during the formation of CBOs.

13.2. Establish rainwater harvesting schemes to capture and use stormwater (Build Operate & Transfer, BOT)

During the community engagement process and baseline assessments, it was identified that households in both communities face severe water shortages daily. Lack of a public supply line, long queues for collecting water from public water tankers and the lack of affordability for private water tankers were issues negatively impacting the communities in ways manifold. Later, when the WSC suit of interventions was laid out in front of the communities, household-level rainwater harvesting systems garnered a lot of support and seemed feasible in the landscape of both Farash Town and James Town. Till now, 650 rooftop rainwater harvesting systems have been established in Farash and James Town. The harvested water is being used at household and communal levels for non-potable purposes.

13.3. Installation of filtration plants for improving access to clean drinking water

The need for filtration plants was identified during the ‘priority identification phase’ of the community engagement process. Installation of filtration plants was initiated with the support of the community. Initially, detailed baseline assessments along with geotechnical and geophysical assessments have been conducted. Moreover, to assess the existing water quality of numerous sources detailed water quality testing has also been conducted to finalize treatment technologies in Farash and James Town. Till now six drinking water filtration plants have been established mainly four in Farash and two in James Town. Based upon initial water quality results and potable water demand four Ultra Filtration systems having a capacity of 2000 l/h each have been installed in Farash Town. However, in James

Town two Reverse Osmosis systems having a capacity of 1000 l/h each have been installed mainly due to higher total dissolved solid (TDS) levels. Through the installation of these drinking water filtration plants, 24,400 people have been provided access to safe drinking water with 10,500 women and 13,900 men respectively. To ensure the sustainability of installed interventions CBO has played a pivotal role by taking care of operation and maintenance through the appointment of operators and development of fund collection mechanisms.

13.4. Construct groundwater recharge pits and wells at suitable public buildings

Based upon the feasibility study conducted in collaboration with PCRWR, twenty-three (23) groundwater recharge interventions have been installed at the household and communal level (19 in Farash Town and four in James Town). The operation and maintenance have been handed over to respective end users. Moreover, monitoring devices have also been installed at each intervention to measure the harvested water. Currently, 3,683 m^3 of water has been replenished by these installed interventions.

13.5. Construction of greywater reuse systems

Installation of three ablution water (greywater) reuse systems at community mosques in Farash Town has been completed. Water from the mosques is passed through treatment chambers containing filter media and finally utilized for horticulture and non-potable purposes within the mosque and nearby park. The installation of greywater reuse systems has been a great success in terms of water reuse for the mosques which has reduced the stress of buying water. Moreover, stakeholders including, CDA and WASA, are planning to upscale these systems at a larger scale in public mosques of Islamabad and Rawalpindi.

13.6. Piezometers along with conductivity, temperature and depth (CTD) divers were installed to assess the impact on groundwater levels

To monitor groundwater levels at the project sites, three piezometers have been installed, two in Farash Town and one in James Town. The objective of this activity was to create a robust dataset for monitoring groundwater conditions, which would in turn support environmental management and resource planning. The methodology encompassed site selection, deployment of CTD divers, data storage, and subsequent analysis.

This effort yielded significant findings. It resulted in a comprehensive dataset of groundwater parameters, offering a deeper understanding of the hydrogeological conditions in the study area. The data analysis unveiled crucial trends and insights that can inform sustainable groundwater management practices.

13.7. Improve resilience to climate change and improve livability through strategies

To improve the livability of communities and to reduce the urban heat effect two green spaces were planned in James Town. To implement Australian best practices for water-sensitive urban design, the implementation of creating green spaces was carried out through a holistic approach. In this context, detailed landscape designs have been completed. The designs were finalized by incorporating the best practices of a water-sensitive city approach and urban design to improve livability and increase climate resilience. The construction of three green spaces was completed in September 2024. The green spaces will increase the livability of communities as well as reduce the urban heat effect.

13.8. Project Strategic Advisory Committee meetings

A project strategic advisory committee was established to provide strategic guidance and support to assist APWASI in achieving its goals. Up till now six meetings of the committee have been held and all updates on APWASI and future recommendations were highlighted.

14. Conclusions and Recommendations

The implementation of a water-sensitive city approach in marginalized urban communities under water stress has been well demonstrated under APWASI. Moreover, the novel concepts of water-sensitive urban design and its implementation in a developing country is something communities across the country can build upon. However, to achieve the desired results and to incorporate positive change, some pragmatic recommendations could be considered which are gathered from the literature review, and situational analysis of both demonstration sites:

i. Detailed stakeholders' consultation must be considered to identify Indigenous problems and to retrieve pragmatic and long-term solutions.

ii. Upscaling of community-level demonstration projects to city-level

iii. Inclusion of novel approaches such as the 'water sensitivity approach' at the policy level for water-inclusive urban design

iv. Alternate and more sustainable water resource options should be considered

v. Awareness sessions regarding good practices, water conservation, reuse and nature-based solutions should be incorporated in such marginalized communities.

vi. Monitoring and reporting of water wastage should be done. Moreover, the misuse of potable water for non-potable purposes such as car washing, cleaning, etc., should be highly discouraged.

vii. Water, sanitation and hygiene profiles should be assessed and documented to propose solutions accordingly.

viii. Installation of metering systems and regular monitoring through a designated body or department.

ix. Administrative and governance issues shall be taken up through consultation with both public and private organizations.

x. Regulated groundwater abstraction and use of alternative source and conservation strategies need implementation.

xi. Public water policy should be formulated and incorporated to ensure the success of the recommended procedures and interventions.

Acknowledgement: The authors would highly acknowledge the financial support from the Department of Foreign Affairs and Trade (DFAT) Australia, Australia Pakistan Water Security Initiative (APWASI), WWF-Pakistan Project Team, Hydrology and Risk Consultant (HARC) Austral and International Water Management Institute (IWMI) Pakistan are thanked for their technical support.

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