The effects of changes in land use and land cover on the availability of blue water in the Soan River basin

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Introduction

- Research background

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An inclusive approach for integrated systems: Incorporation of climate in the water-food-energy-land nexus index

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ABSTRACT

Land and water resources are largely used for food production during agricultural activities. Some farm operations are energy intensive and climate is also affected due to the use of fossil energy during the farm operations. Thus, the nexus assessment without considering climate as an indicator may not provide a holistic outlook toward a secure, efficient, and sustainable use of resources. Therefore, this study aimed to incorporate climate as an indicator in the already existing water-food-energy-land nexus methodology. To implement the water-food-energy-land-climate nexus index, the wheat crop production system in Punjab, Pakistan was taken as a case study. Twelve different indicators were normalized and then aggregated to assess the value of the water-food-energy-land-climate nexus index. Higher the value represents better the sustainable production of crops and land suitability. The value of the water-food-energy-land-climate nexus index varied from 0.34 to 0.78 across Punjab indicating a wide range of sustainable wheat crop production and land suitability for wheat cultivation. The northwest region was showing a lower water-food-energy-land-climate nexus index value as compared to the south. The south and central Punjab areas are more suitable for the wheat crop as compared to the north or west. The water-food-energy-land-climate nexus index could also be used as a comprehensive tool to evaluate the performance of other crops as well. It can also help in formulating an inclusive policy for sustainable development goals — such as SDG 2 (elevate food security), 6 (enhance water security), 12 (responsible consumption and production), and 13 (climate action).

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Research paper

Prioritizing major factors affecting groundwater stress using multi-criteria decision methods

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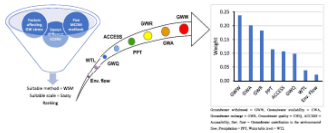
HIGHLIGHTS

- Factors affecting groundwater stress need to be prioritized for sustainable use.
- Groundwater withdrawal is the most important factor affecting groundwater stress.
- The Saaty scale and Weighted Sum Method give relatively precise ranking of choices.

GRAPHICAL ABSTRACT



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https://doi.org/10.1007/s12517-021-08878-3

ORIGINAL PAPER

Flood inundation mapping and hazard assessment for mitigation analysis of local adaptation measures in Upper Ping River Basin, Thailand

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Abstract
Floods have the potential to cause severe damages to humankind around the world. Similarly, the annual monsoon flooding phenomena have had devastating consequences on the Upper Ping River basin throughout the years. The current administrative structure for implementing flood mitigation and adaptation measures lacks effective utilization of locally available resources to provide comprehensive protection against flood-triggered devastation. That is why this study addressed this gap by conducting a flood hazard assessment at the sub-district level. The study assesses flood offsetting potential of local adaptation measures. A modeling approach was used that consists of developing the MIKE 11 and MIKE 21 hydrodynamic models for 1-D and 2-D channel conditions, respectively. MIKE 11 and MIKE 21 models were calibrated against observed discharge and water level (1D) flood extent (2D), respectively. Flood inundation and hazard maps were reproduced and categorized into several classes based on defined critical depths for 2, 5, 10, 25, 50, and 100 years return periods. The flood inundations reproduced on 601.8–996.9 km^2 (2.37–3.94% of total basin area) for 5–100-year return period floods, respectively. Based on flood hazard results, the "high hazard" category took first place with the largest flooded area, followed by "very high hazard" and "low hazard" categories, and the "medium hazard" category was ranked at last place with the least coverage of inundated area. To improve future flood protection, the existing administrative structure for flood adaptation and mitigation has to be updated based on an integrated flood management strategy.

Keywords Flood hazard · Mitigation · Upper Ping River Basin · Adaptation · Flood inundation

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ORIGINAL PAPER

Effect of climate change on cash crops yield in Pakistan

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Abstract
Climate change is a global challenge having a significant potential to alter crop yields worldwide. Thus, the determination of crop yield is important in the prospect of food security for agro-economic regions like Pakistan especially in the upcoming decades. Therefore, the focus of this research was to investigate the historical and projected spatial and temporal changes in climatic parameters, and their impacts on cotton and sugarcane yield in the southeast region of Punjab, Pakistan, by the Mann-Kendall test for baseline (1981–2015) as well as projected (2020–2099) periods. ArcGIS was used to check the spatial variation in climatic parameters between the four climatic stations of south Punjab. Two regional climatic models, the Australian Community Climate and Earth-System Simulator version 1 and Commonwealth Scientific and Industrial Research Organization, Conformal Cubic Atmospheric Model, were used with two representative concentration pathways (RCP), RCP 4.5 and RCP 8.5 scenarios. It was found that the total amount of precipitation can be more than the baseline by 47–68 mm. However, precipitation trends were inconsistent. In summary, there seems to be strong evidence that climate change is influencing especially the temperature trends which were statistically significant in this region. As compared with baseline, the maximum temperature is likely to increase from 2 to 4 °C, and the minimum temperature can increase from 3 to 6 °C until the end of this century. Changes in temperatures can reduce crop yield especially cotton and sugarcane up to 6% and 16% per annum, respectively, until far future.

Keywords Climate change · Temperature · Precipitation · Regional climatic models · Crop yield · Pakistan

Introduction

- Freshwater scarcity is a growing concern
- Changes in LULC has potential to alter water availability
- Interpreting the variations in hydrology is crucial for sustainable water management in the region

Problem Statement

- Impact of changes in LULC on blue water availability can be even severe in arid and semiarid areas

Objective

- To analyze the impact of LULC changes on the blue water availability in Soan River basin, Pakistan

Methodology

- The SWAT model was used to estimate the BWA
- The BWA is the combination of water yield and groundwater storage
- Groundwater storage is the difference between the total amount of water recharge to aquifers (GW_RCHG) and the amount of water from the aquifer that contributes to the main channel flow (GW_Q)

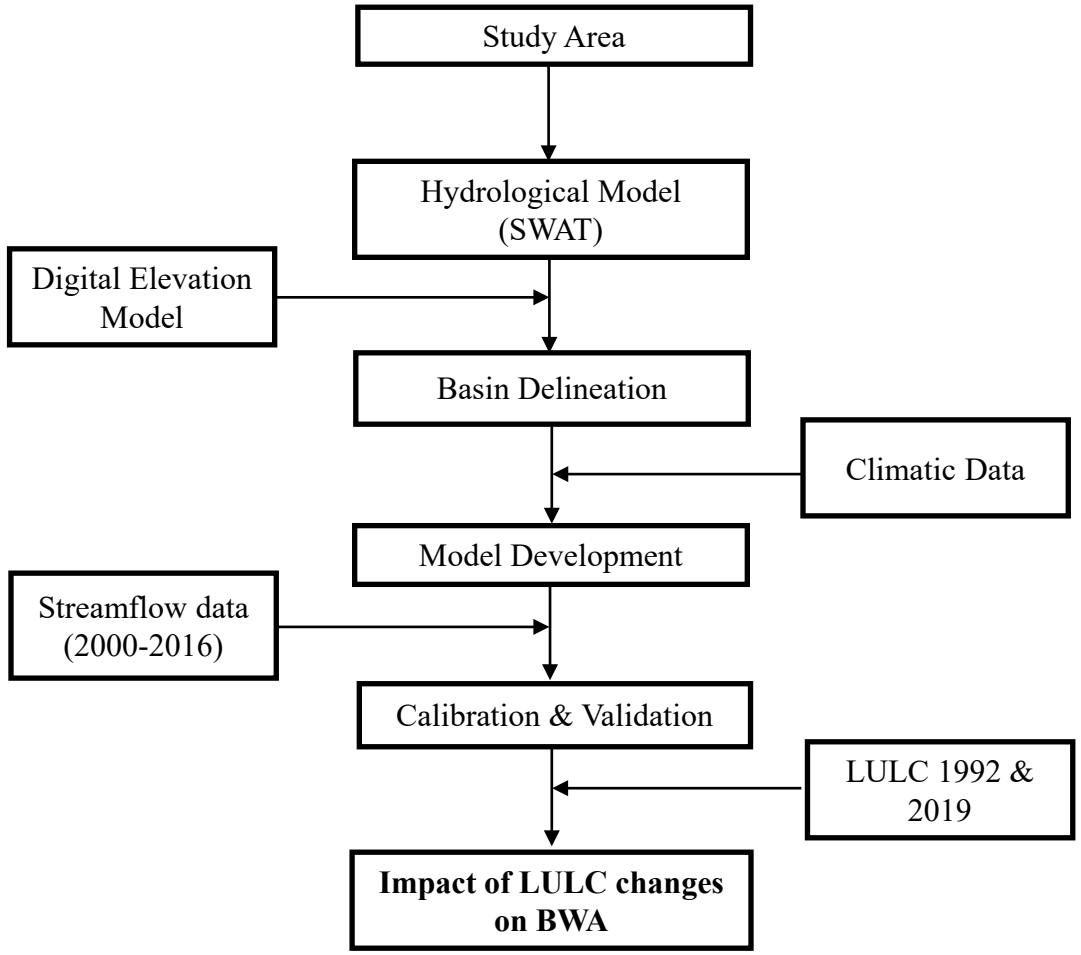
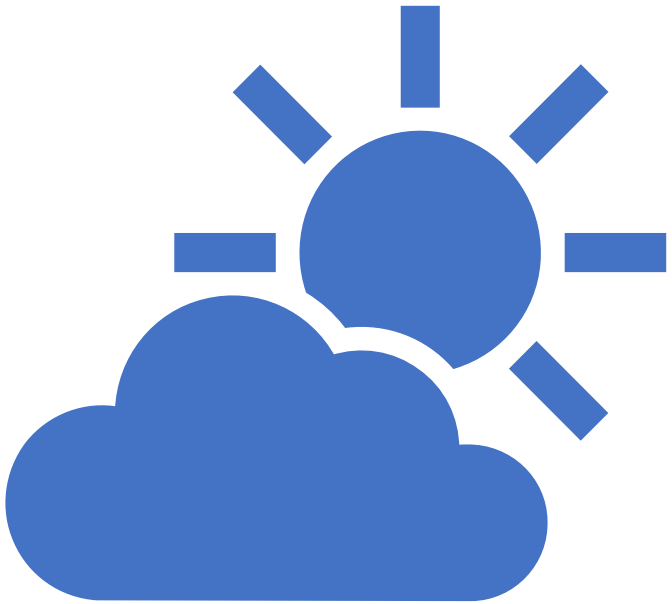


Fig.1 A complete methodological framework of this study



Data Acquisition

- Climatic data obtained from the Pakistan Meteorological Department
- Stream flow data (gauged data) was collected from Water and Power Development Authority, Pakistan
- LULC data from the European Space Agency

Study Area

The Soan River is one of the major tributaries of the Indus River

The Soan River basin covers an area of 6842 km^2

The average annual temperature in basin ranges between 8 to 18°C,

It flows through Islamabad, the capital of Pakistan

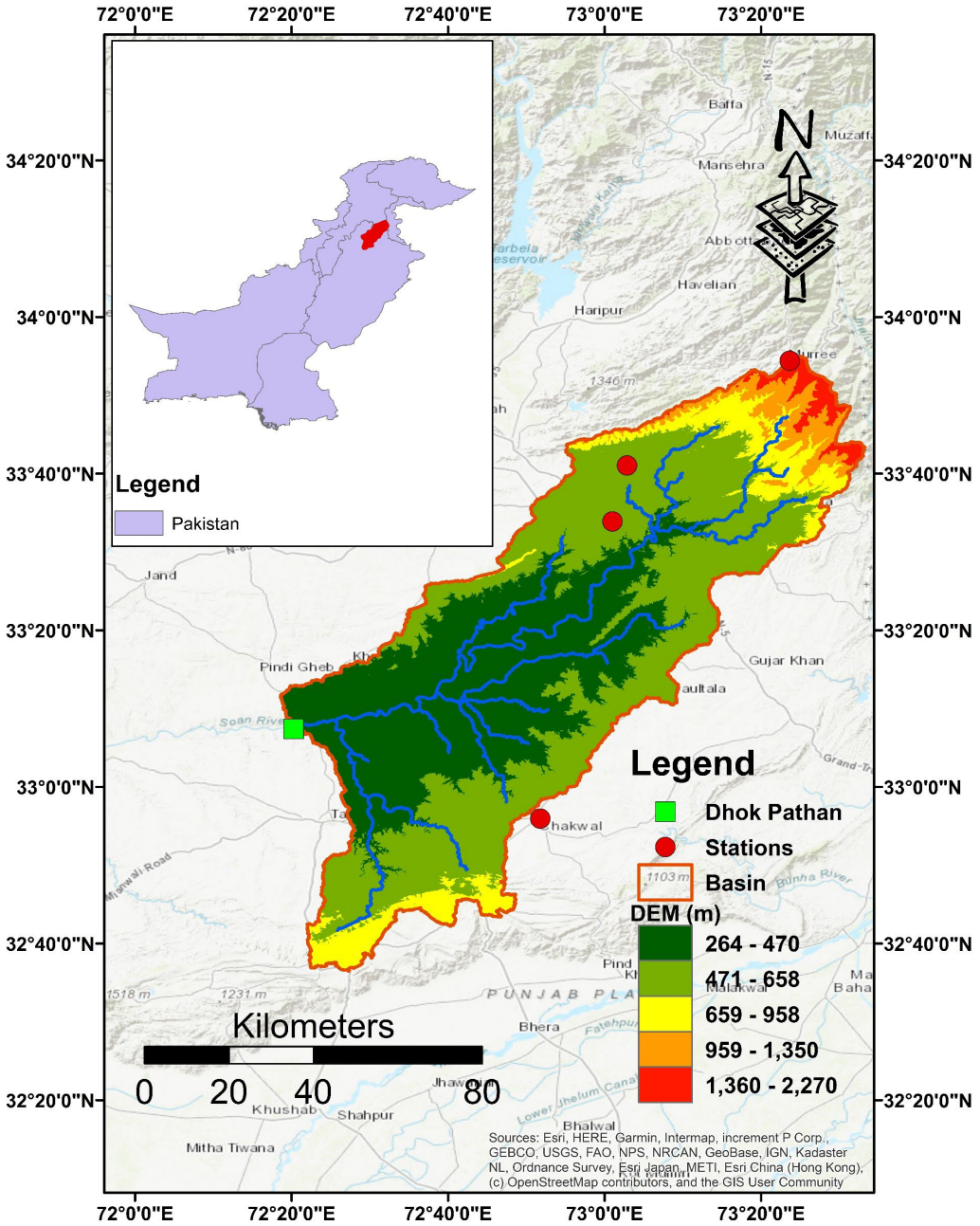


Fig.2 Study area of the Soan River basin, Pakistan

Changes in LULC

- Agricultural land decreased by 4.4% in the last three decades
- Urban land increased by 4%
- Forest cover increased by 0.4% from 1992 to 2019

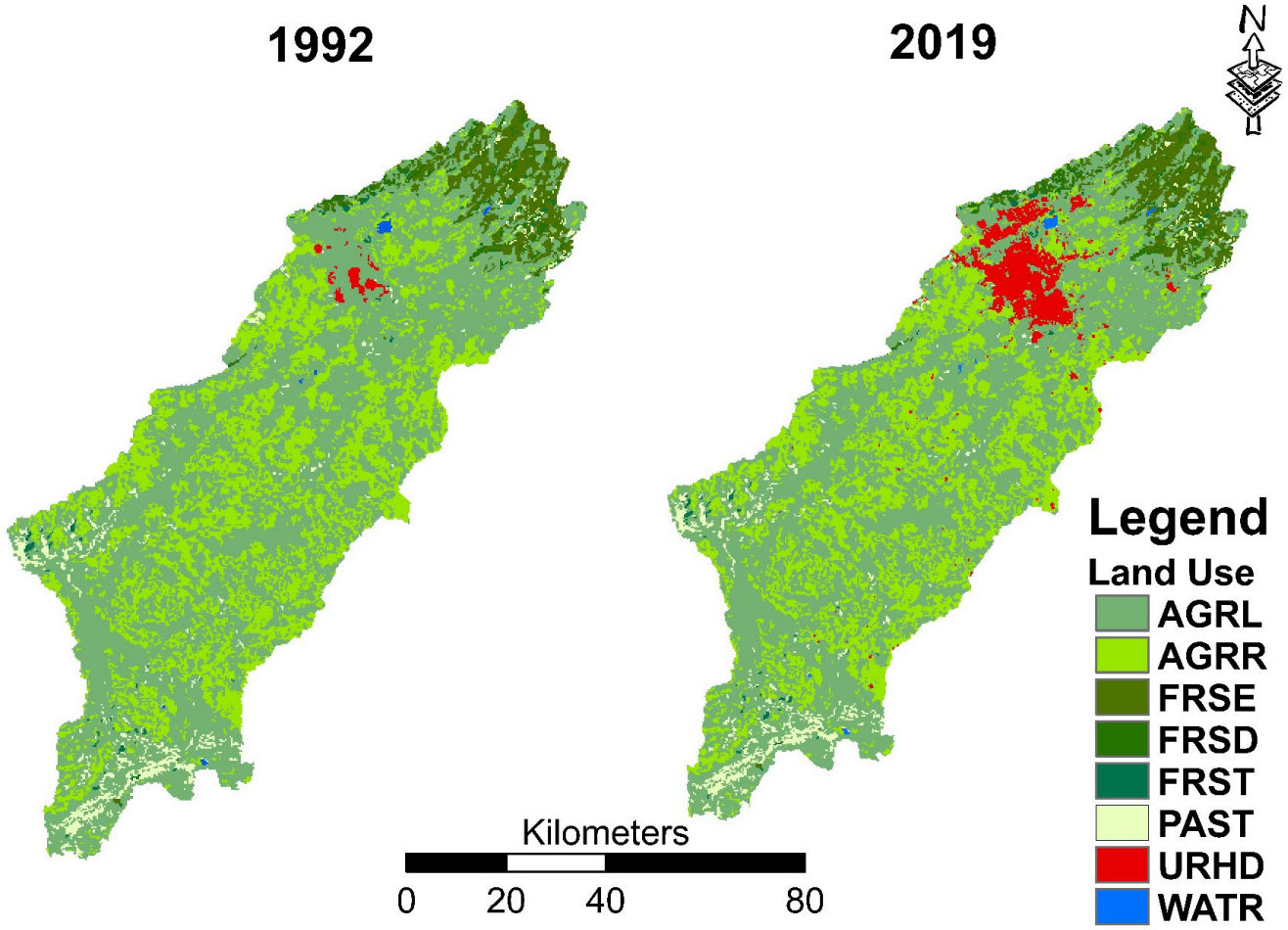


Fig. 3 Changes in LULC in the Soan River basin, Pakistan

Calibration & Validation

- For the calibration period, the values of R^2, *NSE*, and *PBIAS* were 0.72, 0.62, and 3.04, respectively

- For the validation period, the values of R^2, *NSE*, and *PBIAS* were 0.70, 0.69, and 3.03, respectively

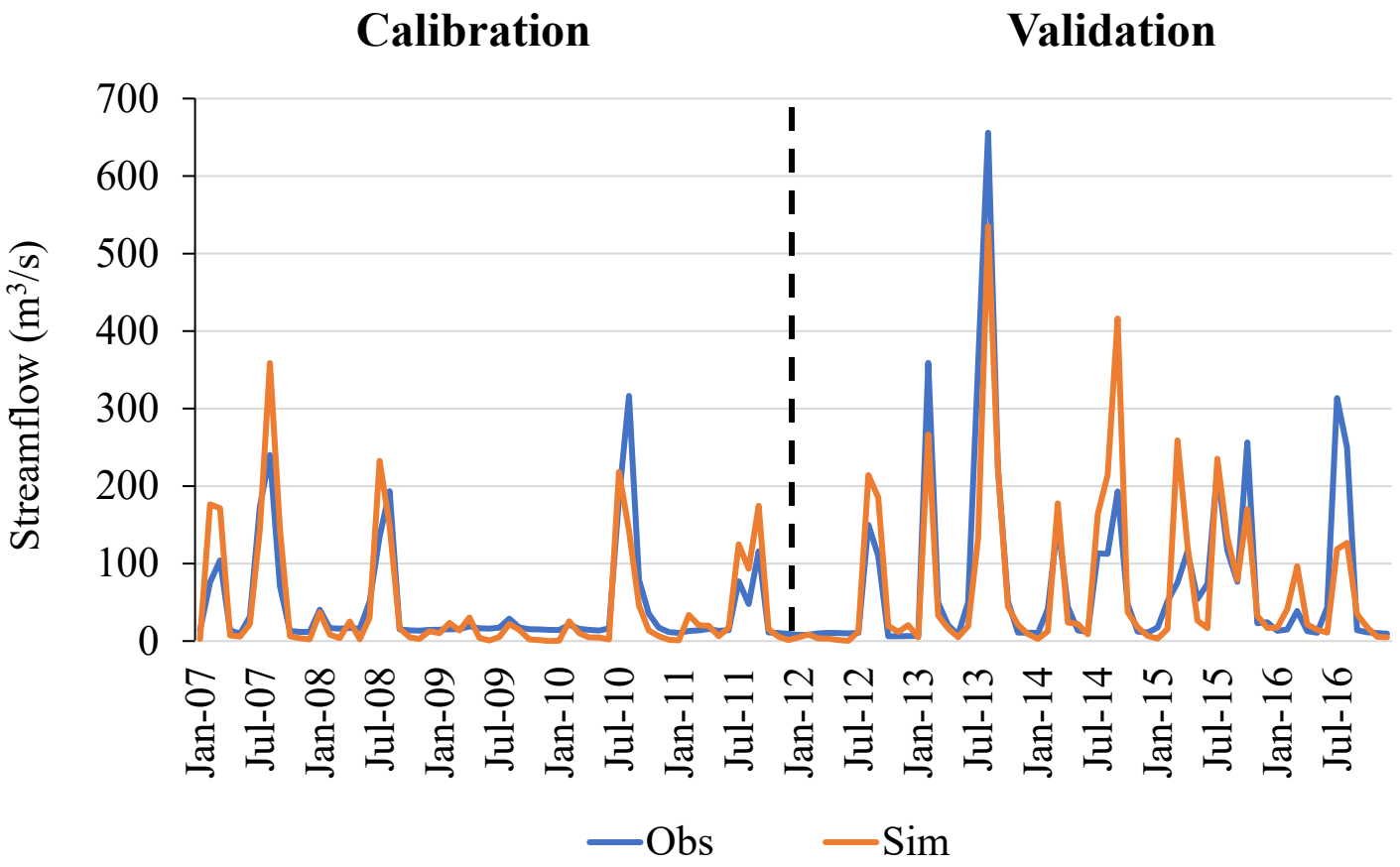
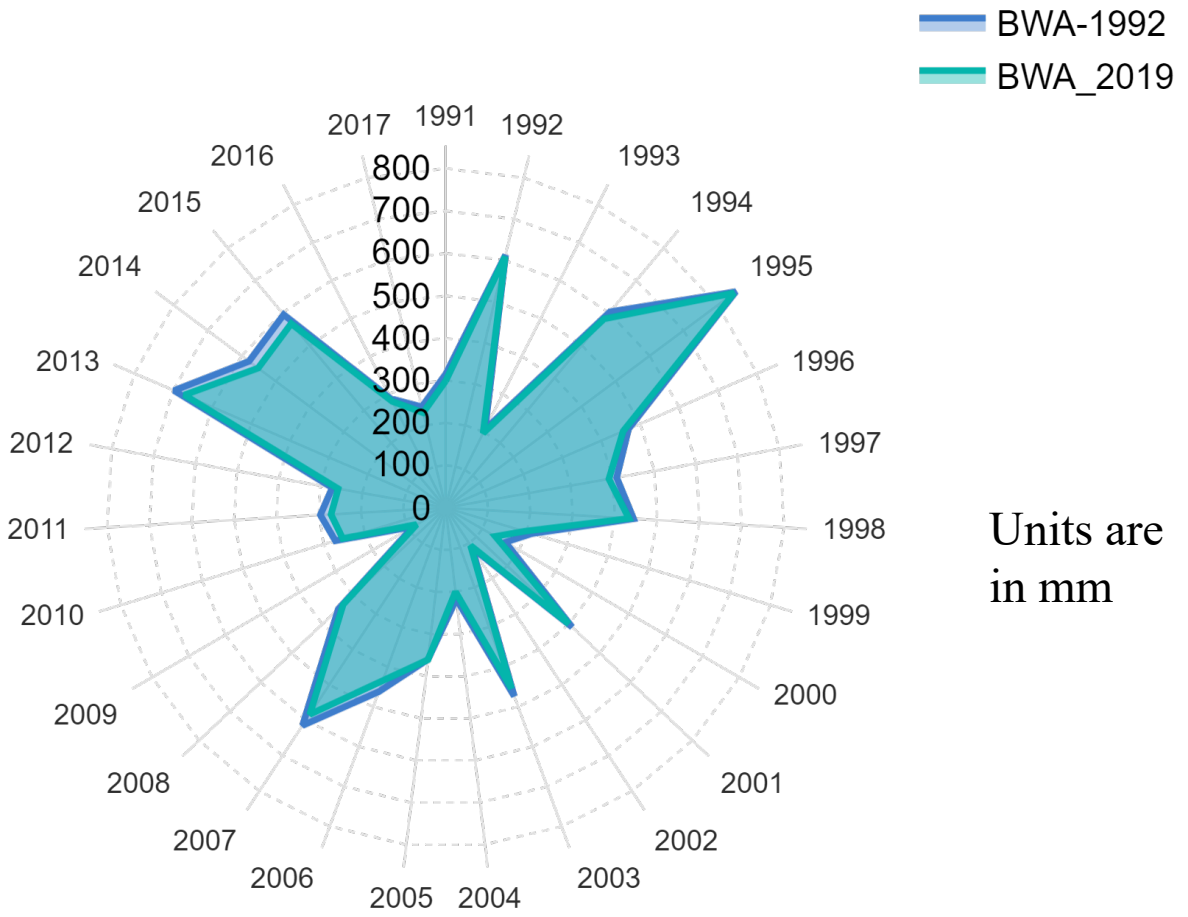


Fig. 4 Hydrograph of simulated and observed runoff for calibration and validation periods

Change in BWA

- BWA was estimated from 1991 to 2017 by using the SWAT model
- Average annual *BWA* decreased from 393 to 377 mm



Units are in mm

Fig. 5 Variations in average annual BWA due to LULC changes

Change in BWA

- The average decadal BWA was 429, 320, and 405 for the 1990s, 2000s, and 2010s respectively under the LULC of 1992

- Average decadal BWA under the LULC of 2019 was 416, 307, and 386 for the 1990s, 2000s, and 2010s, respectively

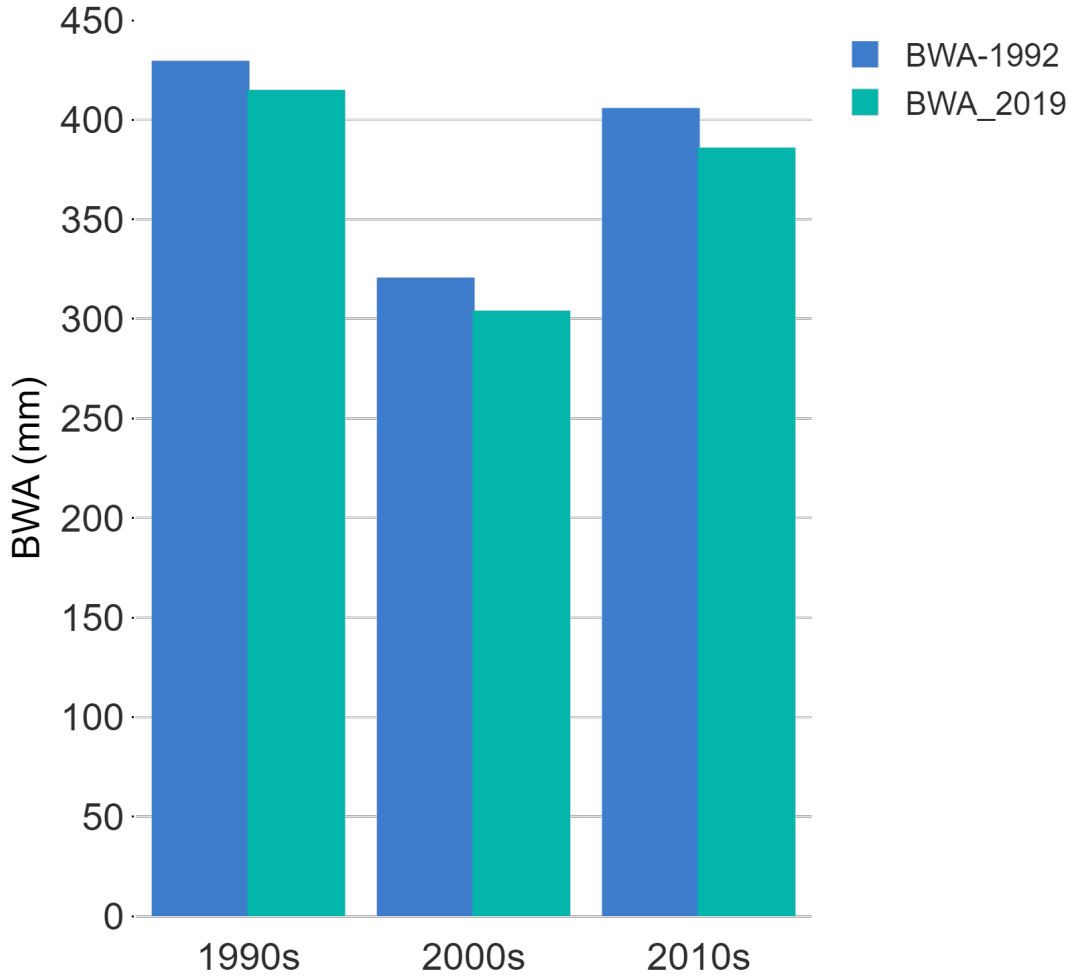


Fig. 6 Variations in decadal BWA due to LULC changes

Discussion

- The results of this study can help the policymakers of water resources and water management to achieve SDG 6

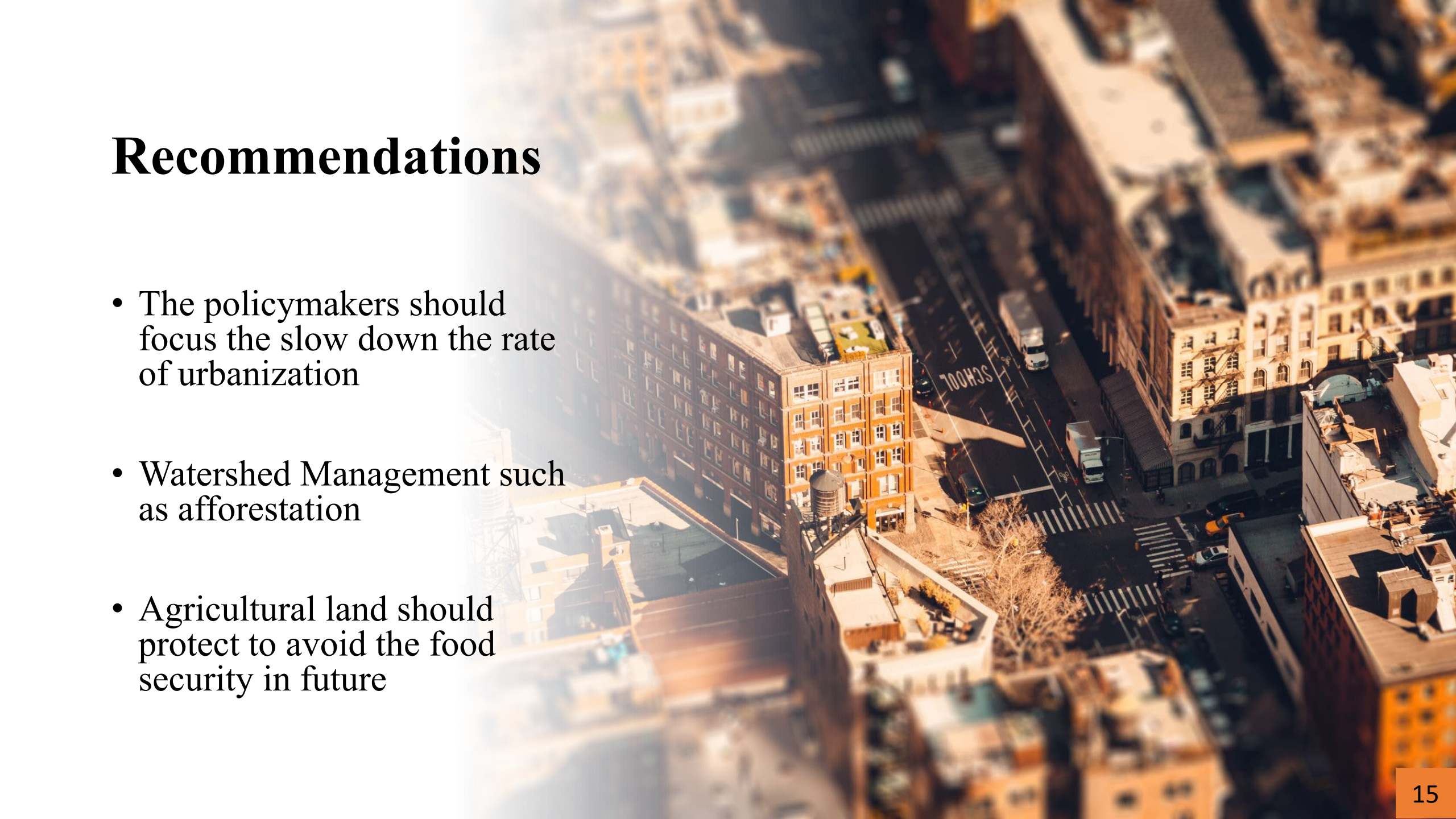
- Almost 86% of the area of the Soan basin is still under agricultural land cover

Discussion

- The decrease in BWA can cause a reduction in water availability for irrigation
- Which ultimately can threaten the food security of the area
- It could also lead to the blue water scarcity issue, especially in the Capital city Islamabad and adjoining city Rawalpindi

Recommendations

- The policymakers should focus the slow down the rate of urbanization
- Watershed Management such as afforestation
- Agricultural land should protect to avoid the food security in future



Conclusions

- Urbanization is rate is quite high
- The decline in agricultural land was noticed
- The BWA is decreasing in Soan River basin
- The main cause of the decline in the BWA is more likely urbanization


THANK YOU

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