Application of Remote Sensing to Estimate the Impact of Floods on Rural Household Income and Sustainable Disaster Mitigation in Pakistan

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Abstract

While the economic impact of natural disasters has been studied extensively, there are rather few studies that have addressed their impact on household income. This research tries to fill this gap by analyzing their actual effect on household income, multidimensional poverty, and lastly give mitigation strategy for the 2010 flood. Firstly, the findings can give policymakers insight in terms of strategies to develop agriculture and non-agriculture employment opportunities. Secondly, it is essential to reduce income vulnerability, poverty and improve rural household finance economic conditions. Secondary data from reputable international organizations, the International Food Policy Research Institute (IFPRI), was used first to see the extent of household losses. Remote Sensing (RS) Images, Global Positioning System (GPS) coordinates, and Geographical Information System (GIS) software packages have been used for regression analysis and calculation of distance, respectively.

This research tries to look at the impact of natural disasters on rural households in Pakistan after a massive flooding event in 2010. Flood loss means accounted for Pakistan Rupees 43,000, while others are far less like drought mean loss was PKR 2,938 followed by earthquake, fire, and others. This study has used the Difference-in-Difference (DID) approach, which showed statistical significance at 1 percent. The regression results show that households affected by the 2010 flood is 3.382 in the proportion of their income. Whereas, after adding all control and fixed effect, the coefficient change is 3.440, with statistically significant at 0.001 (statistically highly significant as $P < 0.001$). For the DID estimates, all models show it shows statistically significant at 0.001. The losses are highest for the households which live closer to the river; the coefficient of an estimate is 3.908 percent and statistically significant at 0.001. If the household is living at 5 kilometers (km), then the effect of the flood 2010 is highest as compared to the other distances up till 60 km after it there is no change. The results showed that the sample households living near had more impact as compared to the ones living far.

Multidimensional approach is used to calculate poverty by using the methodology used in Poverty Reduction Strategy Paper (PRSP), which calculates it based on household living conditions. This index scale categories households from a minimum score of 1 and a maximum score of 16. This analysis used the survey done years 2011-2012, 2012-2013, and 2013-2014 for poverty measurement to see the effect of flood 2010. This method is the best fit strategy to see poverty after such flooding events. The notable change in this scale was seen at 5, in 2012 shows 14.22 percent; in 2013, it decreases to 10.55, and in 2014 the value increases again to 13.23

percent. Lastly, on district-level, Thatta had the lowest mean score of 3.018. At the same time, the Attock district had the least poverty by showing the highest mean score with 11.264.

Lastly, the Normalized Difference Vegetation Index (NDVI) analysis is used to finding the best suitable locations for flood shelter areas to have disaster mitigation. The modeled result indicates a most hazard-prone area classified based on flood shelter as restricted 1,587 km^2, not suitable 4,657 km^2, not livable 730 km^2, Average 2,690 km^2, livable 1,618 km^2, suitable 859 km^2 and most suitable 388 km^2. Firstly, in terms of the percentage, only 3.1 percent of the land of the case study area is most suitable for shelter during flooding (September, 2010), and after the flooding (December, 2010) it was 7.49 percent because the flood water descended and waterways move back to the original state of water flow. The data analyzed show although the suitable areas for construction are about 10 percent (suitable 859 km^2 and most suitable 388 km^2, which is 3.10% and 6.85% = 9.95%) of the total land of Thatta district even then, the maximum usage of these areas should be ensured. Secondly, during a flood, the restricted area was 12.66 percent and not suitable is to 37.16 percent area (12.66+37.16= 49.82), making the area total inhabitable area as 49.82 percent. Whereas after the flooding, the restricted area is 30.5 percent and not suitable as 12.44 percent (30.5+12.44= 42.94). The increase of 6.88 percent (49.82-42.94=6.88) of the areas during the flood is because of the breaches of the river, canals, waterways, and irrigation systems, causing the wide spend of water, making the river and restricted areas less, but increasing the not suitable area. The Thatta union council disaster map shows that a total of 47.16 percent of the land is vulnerable to flooding, 13.2 percent to moderate level of flood, and 39.61 percent like at low ranked in terms of the risk of flood. This research tried to provide insight into the area more vulnerable and areas not suitable for the construction of relief camps, hospitals, or any such strategical vital places for better disaster management and planning.

Keywords: Rural household, Income vulnerability, Difference-in-Difference, Remote sensing, NDVI Analysis.