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Mini Review

Flooding Impacts to Agricultural Lands with Changing Climate

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A Perspective

The United Nations, through its Sustainable Development Goals (SDGs), promotes the eradication of hunger and clean accessible water to all, for both consumption and irrigation purposes (https://sdgs.un.org/goals/goal2). Progress at the global scale requires the continuous production and supply of agricultural products [1]. However, climate change poses a significant threat due, in part, to impacts from larger and more frequent floods and severe storms [2-4]. Between 2008 and 2018, floods alone caused $21 billion in agricultural losses in developing countries [5,6].

Traditional flood hazard studies have primarily focused on the loss of human life and the economic impact on infrastructure from flooding [7,8]. However, despite the severity of the situation, relatively less priority has been given in practice and in research literature regarding the impacts of floods on agricultural lands and food production/shortages, especially in the context of current challenges as they relate to climate change [9,10] and flood infrastructure that provide risk reduction [11].

The impact of floods on agricultural land is both direct and indirect [12]. Direct impacts include losses due to direct exposure to flooding, such as crop yield reduction and soil erosion, while indirect impacts encompass losses not directly caused by flooding, such as delays in product supply from flooded areas, but also geomorphological and fluvial impacts [13]. This raises a key question: "why for flood inundation maps and corresponding emergency action plans for temporary flood protection measures are agricultural lands not a higher priority for protection?" Certainly, human life is paramount but the risk to human life after flood waters recede has not passed if food shortage, sanitation, and clean water are not available for extended periods.

Direct impacts have been quantified by some researchers both on the global and national scales in an effort for advancement and improvement. For example, Kim, et al. [14] used global flood inundation model output and historical crop yield maps to estimate flood-induced crop yield damages for the years 1982-2016. Similarly, Craig, et al. [15] utilized flood inundation maps (2D numerical models) and agricultural data for New Zealand to quantify changes in agricultural land extent and yearly earnings due to direct exposure to flooding from 1990 to 2016.

Despite the various flood impact studies on agricultural land, there are limitations in these studies that do not reflect the current state-of-the-art modeling applied to other aspects of flood impacts. Firstly, uncertainties in models and modeling approaches can be overlooked [16], and uncertainties in hydrological and hydraulics data used to prepare flood inundation maps can also be significant, especially for extreme floods [17]. Secondly, uncertainties in agricultural data may also not be adequately quantified [14]. Finally, many models and flood impact analyses are conducted in response to a significant event and may not provide insight into the direct impact floods and climate trends may be having on agricultural lands. Consequently, conclusions drawn from such studies may not fully provide the perspective necessary to efficiently advance agricultural policy decisions at both the global and national scales.

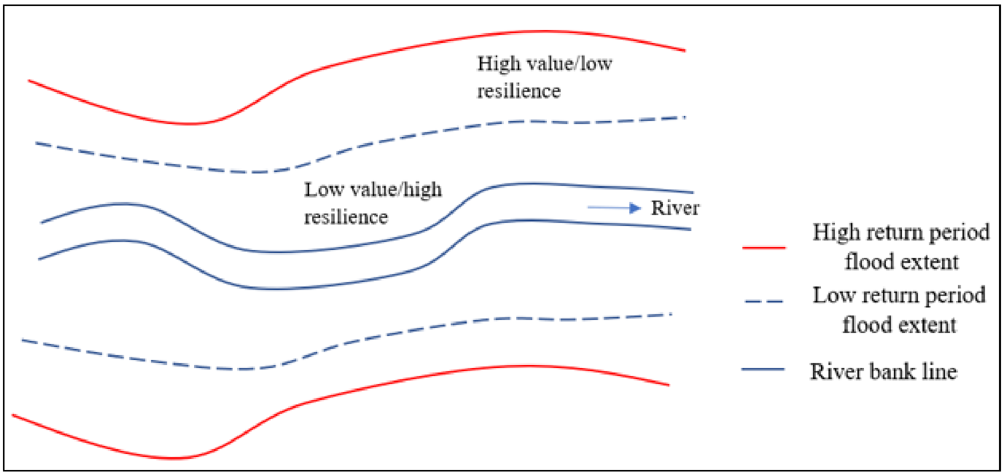

Figure 1: Risk gradient for agricultural land resilience against floods due to climate change.

Addressing the impact of floods on agricultural land amid climate change is indeed complex due to annual and decadal changes storms, impacts, and agricultural practices. The uncertainties surrounding future flood prediction can be significant if state-of-the-art modeling and risk assessments are not performed. This complexity raises a crucial question: What pathways are most effective for mitigating the impact of flooding on agricultural land as the climate changes?

One potential solution involves stratifying the use of agricultural land within floodplains based on the agricultural value (high or low) and the resilience of crops (high or low) (Figure 1). Areas prone to frequent flooding, characterized by low return period floods, could be designated for agriculture that has some level of flood resilience or is of lower economic value. Conversely, areas subject to less frequent flooding, associated with high return period floods, could be allocated for higher-value agriculture and/or focusing on crops that are less storm and flood resilient. This approach leverages the concept of risk management to optimize agricultural output and resilience in flood-prone areas, which could be combined with flood infrastructure projects and aligning agricultural practices with the anticipated frequency and severity of flood events in changing climate.

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Conflict of Interest

The authors declare no competing interests.

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