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Assessing the Severity of Consequences of Floods in Pakistan: Applying the ISM Modelling and MICMAC Analysis

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Abstract
The study aims to assess the severity of the consequences of floods in Pakistan. The study's overall design includes reviewing relevant literature, collecting data from primary sources, and modeling & analyzing the phenomena. The population under study comprises the folk stakeholders of the phenomenon. The sampling design is purposive (focus group consisting of experts), whereas the sample size is fourteen experts, i.e., a medium size panel. The method of modeling is Interpretive Structural Modelling (ISM) and the method of analysis is Cross Impact Matrix Multiplication Applied to Classification (MICMAC). Results of ISM modeling show that consequences namely, reduced food supply, destroyed crops, destroyed food stockpiles, destroyed infrastructures, economic strain on entire population, and disruption in trade and commerce inhabit Level I. Consequences namely: lost livelihoods of farmers, destroyed livestock, destroyed equipment, injuries and deaths, disrupted schedules of transportation, inundate agricultural lands, reduction in soil fertility and increased prices inhabit Level II. The consequence namely: destroyed seeds inhabit Level III. The consequence: displaced populations inhabit Level IV. The consequence: damaged and destroyed housing inhabit Level V. The consequence: spreading of waterborne diseases inhabit Level VI. Results of scale-centric MICMAC analysis show that spreading of waterborne diseased is independent, and reduced food supply is dependent quadrant bur all other are linking and there is no autonomous factor. Results of data-centric MICMAC analysis show that destroyed seeds, destroyed equipment, and spreading of waterborne diseased are independent and lost livelihoods of farmers, reduced food supply, destroyed food stockpiles, destroyed livestock, destroyed infrastructures, damaged and destroyed housing, displaced populations, and disruption in trade and commerce are dependent quadrant. Destroyed crops, economic strain on entire population, injuries and deaths, disrupted schedules of transportation, inundate agricultural lands, reduction in soil fertility, and increased prices are linking. The autonomous quadrant is empty as there is no factor categorized in this quadrant. It is an original valuable study because it is based on real time experimental first-hand data collected by authors that have hands on job of data collection for decades. It also uses unique and different methodologies to collect data, modelling and analysis. This methodology is simple, unique and clearly understandable by wide range of folks of stakeholders. Its results are also logically appealing and realistic corresponding to ground realities. The will enrich the understanding of national/local governments, regulators, industry representatives, landowners/farmers, general public (including households, local communities, village committees community workers local labor, disabled people, minorities, senior citizens and women etc.), scientific community and others contributors to the system, institutions engaged in disaster management, international donor agencies, academia, politicians & political parties, flood-prone communities, NGOs, volunteers, regional institutions, media, suppliers of goods & material, civil organizations, private institutions and other affected, interested or vulnerable groups (like social beneficiary groups, non-social beneficiary groups, social adversely affected groups and non-social adversely affected groups) by way of deeper insights into the conundrum issue of floods.
Keywords: Floods Aftermaths, ISM, MICMAC

1. Introduction
In Pakistan, floods have posed significant challenges impacting all spheres of life including health, economic, social, political, and infrastructure. Drawing on recent research, this article provides a snapshot of flood consequences in Pakistan. It attempts to explore the direct as well as indirect impacts of flood including public health issues, economic issues, losses to people, environmental damages, and loss to agriculture. Drawing on recent losses and challenges posed by flood events, the study attempts to provide a better understanding of the multifaceted issue of flood in Pakistan and offer insights into its mitigation strategies. Floods are considered recurrent natural disasters in Pakistan. Every year, it is driven as a combined effect of monsoon rains, glacial melts, and river overflows resulting in huge losses to the country. Pakistan's specific geographic and climatic conditions lead its residents to face severe challenges because of flooding. This research highlights the impacts of flooding on various sectors to explore immediate and long-term effects. Pakistan is situated in a region where climatic conditions force it to experience significant seasonal variations in rainfall, particularly during the period from July to September known as the monsoon period. Additionally, glacial melts in the Himalayas exacerbate flooding during monsoon. Due to its geographic and climatic conditions, Pakistan is susceptible to severe challenges from floods. Floods have a recurrent history in Pakistan with severe events in 2010 and 2022 floods. The 2010 and 2022 floods are described as one of the worst natural disasters in the country's history. The 2022 event created total damages to exceed USD 14.9 billion, and total economic losses of about USD 15.2 billion. Rehabilitation and reconstruction costs are estimated at USD 16.3 billion. Similarly, the 2022 floods led to extensive damage and humanitarian crises across the country (WDI, 2022). The multifaceted impacts of floods influence various aspects of life. These impacts can broadly be categorized into economic, health, displacement, and environmental repercussions. Floods in Pakistan have significant effects on the country's economy. The Economic impacts due to flooding include Infrastructural Loss, Agricultural loss, and Business damages. The Floods destroy buildings, roads, and bridges. Further, the cost incurred in repair and reconstruction drains national budgets for other critical sectors (Pakistan: Flood Impact, 2011). Flooding also destroys crops and livestock, causing significant economic losses and food supply. For example, the 2010 floods damaged approximately 2.3 million hectares of crops. Due to infrastructure damage, small and medium enterprises are particularly affected by floods. these as infrastructure also disrupt supply chains leading to business closures and economic downturns (Khalid & Khaver, 2020). Loss in gross domestic product (GDP) as in the 2022 floods, is projected to be around 2.2

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percent of GDP. The agriculture sector contracted the most, at 0.9 percent of GDP. The damage and losses in agriculture had spillover effects on the industry, external trade, and services sectors. The health consequences of flooding are profound and multifaceted. It causes disease outbreaks such as hepatitis, cholera, and typhoid. During The 2010 floods, a significant increase in waterborne diseases was seen (Alderman et al., 2012; Paterson et al., 2018). Floods also create mental health issues. The displacement and loss of property cause anxiety and depression in people. The trauma of a beloved's life, home, and livelihood has long-lasting psychological repercussions (Paterson et al., 2018). Flooding also affects health services. The damaged health infrastructure due to floods disrupts medical supply chains, further aggravating public health crises (UNICEF Humanitarian Action: Preparing for Children in emergencies, 2010).

Floods also cause large-scale displacement affecting millions of lives. The displaced people are forced to live in temporary shelters with inadequate facilities further aggravating the disease outbreak (he International Federation of Red Cross and Red Crescent Societies (IFRC), 2021), disruption of social networks, increased social tensions, and disruption of the education system for children, with long-term effects on educational attainment and future opportunities. Lastly, the Floods have significant environmental repercussions including ecosystem damage and water contamination. Flooding leads to soil erosion, vegetation loss, and local ecosystem disruptions affecting biodiversity and the ecological balance (Aldardasawi & Eren, 2021). It also contaminates and degrades water quality affecting both human and environmental health (Fida et al., 2023). As the floods cause indemnifications, effective flood management and rehabilitation initiatives are desirable. In this regard the need for infrastructure improvements, disaster preparedness policy-making, and planning for effective implementation is crucial. Modernizing infrastructure with flood defense and improved drainage systems to withstand extreme weather events is essential (Sokhin, 2015). Early alert systems and community awareness programs can alleviate the damage while Educating communities about flood risks and response strategies is vital (Kuller et al., 2021). Furthermore, including flood risk avoidance and management in national and regional planning would lead to a coordinated response to avoid damages (PAKISTAN FLOODS 2022 Post-Disaster Needs Assessment, 2022).

Additionally, the need for the research community to raise awareness concerning the severity of the flood aftermaths is complementary to finding the solution. The insufficient literature on the aftermaths of floods contributes to the non-serious behavior of administrators in dealing with the damages. Effective control of the issue requires effective defense and mitigation planning that further depends on the availability of information on the issue. The insufficient information leads to wrong planning and mitigation strategies further exacerbating the problem. Therefore, the current research attempts to provide useful information on the aftermath of flooding in Pakistan. Admittedly, the phenomenon of floods is the area that contains crystalized technical research with uses of a wide variety of methodologies but since it is the ever-green area of research because of the changing climate and having many dimensions and a wide variety of changing consequences, therefore, needs rather more studies. There is a plethora of research on technical aspects of the floods, but the common and social aspects are less studied and qualify for more serious research. The current study addresses one of these common but important aspects i.e. consequences of floods in Pakistan. The specific objectives of the study are: i) to expound the consequences of floods in Pakistan, ii) to assess the relationships among them and put them into the order of severity, iii) to unveil the structure of relationships among consequences in the form of a hierarchical structural model, iv) to analyze and classify the consequences on the bases of dependencies and v) to develop some policy guidelines for regulator stakeholders. Therefore, specific research questions are: Which are the usual necessary consequences of floods for stakeholders to be prepared on high priority? Which consequences are relatively less severe? What are the contextual relationships among the consequences and how they can be classified? To answer these questions and achieve the research objectives a plethora of methodologies is available in contemporary research literature. An Array of methodological choices was considered to achieve the objectives of the study. It includes considering Interpretive Structural, Modelling (ISM), Cross Impact Matrix Multiplication Applied to Classification (MICMAC), Data Envelopment Analysis (DEA), Grey Relational Analysis (GRA), Total Interpretive Structural Modelling (TISM), Modified-TISM, Polarized-TISM, Fuzzy-ISM/TISM, Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Stepwise Weight Assessment Ratio Analysis (SWARA), VIekriterijumsko KOmpromisno Rangiranje (VIKOR), Decision making trial and evaluation laboratory (DEMATEL), Wavelet Analysis (WA), Structural Equation Modelling (SEM),Analytical Hierarchy Process (AHP), Analytical Network Process (ANP), Artificial Neural Networks (ANN), as possible choices Multi-Objective Optimization on the basis of Ratio Analysis (MOORA). It is also considered to use the methods in combination. ISM in combination with MICMAC is found to be the most appropriate because of its simplicity and ease to apply & understand (Abbass, et al., 2022; Basit, et al. 2021; Fu, et al. 2022; Niazi, et al. 2021; Niazi, et al. 2023; Qazi, et al. 2020; Qazi, et al. 2022; Qazi, et al., 2019; Niazi, et al., 2021a; Niazi, et al., 2023c). ISM coupled with MICMAC is therefore used to address the research questions aforementioned. The ISM and MICMAC suit situations where researchers aim to explore the factors and/or consequences of a particular phenomenon and order them in a sequence of their criticality. The chosen techniques along with their merits are described in the 'Methodology' section.

Briefly, the ISM is useful for creating a hierarchy of factors/aftermaths acquired from experts through structured questionnaires whereas the MICMAC classifies the factors/aftermaths into cartesian planes and complements the ISM. The research has theoretical and practical implications described in the "Implications" section. It offers practical applications for a broad range of audiences including the general people, administrators, society, and the economy. It is useful to raise awareness concerning such critical issues that result in huge losses. Moreover, it has implications for environmental regulatory authorities, society, and the economy at large for policy making. A strategic plan can be formulated involving authorities (e.g., government), policy-makers, and organizations to control the emergence and avoid aftermath in the future. The paper is organized into five sections, with a review of literature in the second section, methodology in the third section, analysis, results, discussion in the fourth section, and conclusion in the fifth section.

2. Literature Review

A review of the literature paves the foundation for finding and justifying the research gap and consequent research objectives. For this purpose, a comprehensive review has been conducted using Google Scholar as a search engine and documents extracted belong to renowned publishers such as ScienceDirect (Elsevier), JStor, Wiley-Online, Taylors & Francis Springers, etc. The documents reviewed were extracted using keywords such as, ‘flood in Pakistan’, ‘Flood consequences’, ‘health effects of floods’, ‘environmental effects/repercussions of floods’, ‘economic aftermaths of flooding’, ‘flood early warnings’, ‘social obstacles to implement floods early warning systems’, ‘early warning systems of floods’, ‘floods in Pakistan’, ‘issues of floods early warnings’, ‘social issues of flood warnings’, etc. Drawing on recent findings on floods in Pakistan, the following paragraphs explore the social, economic, environmental, and health consequences of floods, highlighting the most critical insights from contemporary research. Floods are recurrent events having direct and indirect social implications. (Rufat et al., 2015)emphasized that floods aggravate the problem of social inequalities, as marginalized communities are often forced to reside with fewer facilities due to economic constraints. The loss of life, property, and livelihood aggravated the problem of poverty. The displacement of communities and disruption of social networks are also reported as critical consequences of flooding, leading to long-term social repercussions. The economic aftermaths of flooding are vast, impacting both immediate and long-term economic activity. (Brown et al., 2017; Liu et al., 2015) reported direct economic losses of floods such as the disruption of infrastructure, homes, and businesses. Indirect losses such as lost productivity, increased unemployment, and the cost of restructuring also drain the economic budget (Manzoor et al., 2022). Further, the literature shows that insurance companies either charge higher premiums or show reluctance to provide coverage to flood-prone areas affecting economic recovery. Floods have profound environmental aftermaths including ecosystem degradation and loss of biodiversity.

Taylor et al., 2011 highlighted that floods lead to soil erosion, nutrient depletion, and the contamination of water bodies adding pollutants and contaminants. The long-term impacts of floods include the destruction of habitats and the displacement of ecosystem species resulting in a decline in biodiversity. Additionally, the increased frequency and severity of floods contribute to affect environmental conditions making recovery more difficult. The immediate environment losses include contaminated water, air, and land pollution. The long-term impacts are vast. A study by (Aly et al., 2021) investigated the long-term effects of flooding. These effects include disruption of wetlands, forests, and coastal regions. Some ecosystems may eventually recover while others may undergo permanent changes, like shifts in species composition and/or the loss of essential habitats. Additionally, the study emphasized the importance of considering the cumulative impact of recurrent flooding events for effective mitigation. Floods cause both immediate and long-term aftermaths such as outbreaks of waterborne diseases (I-e., cholera and dysentery), (Alderman et al., 2012). The contaminated water and supplies and disruption of sanitation facilities contribute to these health consequences. In addition to the diseases aforementioned, long-term repercussions of floods include psychological effects including anxiety, depression, and post-traumatic stress disorder (PTSD). Floods also affect health services and related supply chains further slowing down the health recovery system. Floods also cause severe psychological and mental health issues, often having long-term effects. Recent studies emphasize recognizing mental health as a crucial aspect of disaster management. For instance, (Paterson et al., 2018) reported that people exposed to floods are at a heightened risk of developing anxiety, depression, and PTSD that are exacerbated by feelings of deprivation from beloved lives, livelihood, and homes. Furthermore, the stress of recovery processes including insurance claims and restructuring homes often aggravate mental well-being.

Flooding has significant effects on agriculture such as reduced crop yields, reduced livestock, and long-term soil disruption leading to serious implications for food security, particularly in regions like Pakistan where agriculture is a primary source of income and sustenance. (Banerjee, 2010; Shrestha et al., 2019) highlighted that floods destroy entire crops leading to food shortages and subsequent increased prices. The effects of floods on agriculture extend beyond the immediate loss of crops to long-term repercussions in the form of soil erosion and the deposition of sediments reducing land fertility. Additionally, the destruction of infrastructure, such as irrigation systems and storage facilities, further exacerbates the food security crisis. Due to climate changes and unplanned urbanization, urban areas are also posed by flood threats. reported the aftermath of urban flooding including infrastructure damage and disruption of essential services like electricity, water, and transportation. These challenges are magnified in urban settings due to the concentration of the population. Furthermore, the growing impermeability of urban landscapes exacerbates flood risks by affecting natural drainage. To sum up, the consequences of floods are vast and interwoven and affect social networks, economic activity, environmental components, and public health. The need of the time is to initiate robust flood management and mitigation as, in recent days, the increased frequency as well as intensity of these floods have posed serious threats to the economy and health. The criticalness of flood issues necessitates raising awareness of such serious issues for timely defense and mitigation strategies. Therefore, the current research covers one aspect of this need by highlighting diverse consequences of the flood. The findings of the research emphasize integrated approaches that can address the social, economic, environmental, and health aftermaths of floods simultaneously, ensuring a holistic response to this recurrent global challenge. As a result of the review of literature, the researchers were able to extract various aftermaths of floods related to health, infrastructure, economy, environment, agriculture, etc. reported as lost livelihoods of farmers (1), reduced food supply (2), destroyed crops (3), destroyed food stockpiles (4), destroyed livestock (5), destroyed seeds (6), destroyed infrastructures (7), destroyed equipment (8) economic strain on entire population (9), damaged and destroyed housing (10), displaced populations (11), injuries and deaths (12), disrupted schedules of transportation (15), inundate agricultural lands (14), spreading of waterborne diseases (15), reduction in soil fertility (16), increased prices (17), and disruption in trade and commerce (18).

3. Methodology

The study is qualitative by nature and follows interpretivism as a research philosophy. The design is a review of literature, data collection, and modeling & analysis. The population is all affected by the phenomenon of flood. The study follows non-probability-based purposive sampling (Tariq, et al. 2023; Shaukat, et al., 2023; Qazi, et al., 2023; Qazi, et al., 2023a) In fact, a medium size heterogeneous type panel of experts is recruited for generating the dataset about the issue (Qazi, Niazi, & Basit, 2020; Niazi, et al., 2020a; Niazi, et al., 2020b). For data collection a matrix type VAXO based ISM questionnaire is used (Farid, et al. 2023; Niazi, Qazi, & Basit, 2019). A real-life field survey is conducted in the office setting of the respondents (Basit, Khan, & Qazi, 2021; Basit, Qazi, & Khan, 2021). The technique of data collection followed is a face-to-face one-on-one semi-structured interview to be recorded on a matrix-type instrument of measurement (Rashid, et al., 2021; Qazi, et al., 2020a; Qazi, Niazi, & Inam, 2019; Abbass, et al., 2022a). The technique of modeling is ISM as used in Niazi, et al. 2023a; Basit, et al., 2019; Basit, Qazi, & Niazi, 2020. The method of analysis is MICMAC (both scale-centric and data-centric) (Niazi, et al., 2020; Niazi, Qazi, & Basit, 2019b). The study used mixed methodology as the MICMAC can corroborate the results of ISM (Shaukat, et al. 2021; Qazi, et al., 2021; Qazi, et al., 2021a).

3.1. Panel of Experts

The panel of experts is needed where there is either no data or the data is insufficient/not reliable (Qazi, Niazi, & Basit, 2021). In this case in hand the authors could not find any secondary data as such. There are two type of panel of experts i.e. homogenous and heterogonous (Niazi, et al., 2019; Niazi, Qazi, & Basit, 2019a). The size of the panel varies from situation to situation depending on type of the panel of experts for homogenous it varies from 12-25, and for heterogonous it varies from 8-18 experts (Basit, et al., 2023; Niazi, et al., 2019a). The study in hand has constituted a panel of experts of fourteen people that is considered suffice to support the study (Niazi, Qazi, & Sandhu, 2019). The criteria for recruitment of the experts on panel is: minimum 10 years works of exposure of facing floods in different capacities, minimum education as university graduate, reasonable exposure to flood related areas and issues, reasonable research acumen and shows willingness to participate in the study as respondent (Niazi, Qazi, & Basit, 2021). The method to elicit data from experts used in this sudy is a structured, semi structured one-to-one, face-to-face in-depth interview capturing data on a matrix questionnaire (Niazi, et al. 2023b). The data gathered from the experts is aggregated in MS Excel sheets using the rule ‘minority gives way to majority (Basit, Qazi, & Niazi, 2020a).

4. Modelling, Analysis, Results and Discussion

Modelling: As a first step towards ISM modelling the data collected from respondents is aggregated by using majority rule and structural self-interaction matrix (SSIM) Table 1 is prepared.

Table 2: Structural Self Interaction Matrix (SSIM)

Code	Consequences of Floods	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Lost livelihoods of farmers		V	V	A	A	A	V	O	O	A	A	O	X	X	A	A	A	A
2	Reduced food supply			A	A	A	A	A	A	V	O	O	A	A	A	A	A	A	A
3	Destroyed crops				A	V	V	A	A	A	O	O	O	O	X	A	V	O	O
4	Destroyed food stockpiles					V	A	V	A	X	O	V	V	X	A	A	A	X	O
5	Destroyed livestock						A	A	A	V	O	V	A	A	A	A	A	V	O
6	Destroyed seeds							V	V	V	A	O	A	X	X	A	V	V	A
7	Destroyed infrastructures								A	A	A	A	A	V	A	A	A	O	O
8	Destroyed equipment									V	A	A	A	X	V	A	A	X	A
9	Economic strain on entire population										A	V	A	A	A	A	X	A	V
10	Damaged and destroyed housing											V	A	O	V	A	A	V	O
11	Displaced populations												A	V	V	A	A	A	A
12	Injuries and deaths													A	A	A	X	X	O
13	Disrupted schedules of transportation														A	A	A	V	V
14	Inundate agricultural lands															A	X	A	X
15	Spreading of waterborne diseased																A	V	O
16	Reduction in soil fertility																	A	O
17	Increased prices																		A
18	Disruption in trade and commerce																		

SSIM (Table 1) is transformed into reachability matrix (Table 2) using rules of binary coding of VAXO.

V: $i \rightarrow j$	A: $i \leftarrow j$	X: $i \leftrightarrow j$	O: $i \not\leftrightarrow j$
1	0	1	0

Table 3: Binary Matrix of Data Points

Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1	1	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0
2	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
3	0	1	1	0	1	1	0	0	0	0	0	0	0	1	0	1	0	0
4	1	1	1	1	1	0	1	0	1	0	1	1	1	0	0	0	1	0
5	1	1	0	0	1	0	0	0	1	0	1	0	0	0	0	0	1	0
6	0	1	0	1	1	1	1	1	1	0	0	0	1	1	0	1	1	0
7	0	1	1	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0
8	0	1	1	1	1	0	1	1	1	0	0	0	1	1	0	0	1	0
9	0	0	1	1	0	0	1	0	1	0	1	0	0	0	0	1	0	1
10	1	0	0	0	0	1	1	1	1	1	1	0	0	1	0	0	1	0
11	1	0	0	0	0	0	1	1	0	0	1	0	1	1	0	0	0	0
12	0	1	0	0	1	1	1	1	1	1	1	1	0	0	0	1	1	0
13	1	1	0	1	1	1	0	1	1	0	0	1	1	0	0	0	1	1
14	1	1	1	1	1	1	1	0	1	0	0	1	1	1	0	1	0	1
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0
16	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	0	0
17	1	1	0	1	0	0	0	1	1	0	1	1	0	1	0	1	1	0
18	1	1	0	0	0	1	0	1	0	0	1	0	0	1	0	0	1	1

The reachability matrix (Table 2) is then transformed into Fully Transitive Binary Matrix of Data Points (Table 3).

Table 4: Fully Transitive Binary Matrix of Data Points

Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Deriving:
1	1	1	1	1*	1*	1	1*	1*	1*	0	0	1*	1	1	0	1*	1*	1*	15
2	0	1	1*	1*	0	0	1*	0	1	0	1*	0	0	0	0	1*	0	1*	8
3	1*	1	1	1*	1	1	1*	1*	1*	1*	1*	1*	1*	1	1*	1	1*	1*	18
4	1	1	1	1	1	0	1	1*	1	1*	1	1	1	1*	0	1*	1	1*	16
5	1	1	1*	1*	1	0	1*	1*	1	0	1	1*	1*	1*	0	1*	1	1*	15
6	1*	1	1*	1	1	1	1	1	1	1*	1*	1*	1	1	1*	1	1	1*	18
7	1*	1	1	1*	1	1*	1	1*	1*	0	1*	1*	1	1*	0	1*	1*	1*	16
8	1*	1	1	1	1	1*	1	1	1	0	1*	1*	1	1	0	1*	1	1*	16
9	1*	1*	1	1	1*	1*	1	1*	1	1*	1	1*	1*	1*	1*	1	1*	1	18
10	1	1*	1*	1*	1*	1	1	1	1	1	1	1*	1*	1	0	1*	1	1*	17
11	1	1*	1*	1*	1*	1*	1	1	1*	0	1	1*	1	1	0	1*	1*	1*	16
12	1*	1	1*	1*	1	1	1	1	1	1	1	1	1*	1*	1*	1	1	0	17
13	1	1	1*	1	1	1	1*	1	1	1*	1*	1	1	1*	0	1*	1	1	17
14	1	1	1	1	1	1	1	1*	1	1*	1*	1	1	1	1*	1	1*	1	18
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1*	1	1*	18
16	1	1	1*	1	1	1*	1	1	1	1	1	1	1	1	1	1	1*	1*	18
17	1	1	1*	1	1*	1*	1*	1	1	1*	1	1	1*	1	1*	1	1	1*	18
18	1	1	1*	1*	1*	1	1*	1	1*	0	1	1*	1*	1	0	1*	1	1	16
Dependence:	17	18	18	18	17	15	18	17	18	8	17	17	17	17	6	18	17	17	

Table 5: Iteration 1

Code	Reachability	Attendance	Set Product	Level
1	1,2,3,4,5,6,7,8,9,12,13,14,16,17,18	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,3,5,6,7,8,9,12,13,14,16,17,18	
2	2,3,4,7,9,11,16,18	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	2,3,4,7,9,11,16,18	*I*
3	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	*I*
4	1,2,3,4,5,7,8,9,10,11,12,13,14,16,17,18	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,2,3,4,5,7,8,9,10,11,12,13,14,16,17,18	*I*
5	1,2,3,4,5,7,8,9,11,12,13,14,16,17,18	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,3,4,5,7,8,9,11,12,13,14,15,16,17,18	
6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,3,6,7,8,9,10,11,12,13,14,15,16,17,18	1,3,6,7,8,9,10,11,12,13,14,15,16,17,18	
7	1,2,3,4,5,6,7,8,9,11,12,13,14,16,17,18	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,2,3,4,5,6,7,8,9,11,12,13,14,16,17,18	*I*
8	1,2,3,4,5,6,7,8,9,11,12,13,14,16,17,18	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,3,4,5,6,7,8,9,11,12,13,14,16,17,18	
9	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	*I*
10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,16,17,18	3,4,6,9,10,12,13,14,15,16,17	3,4,6,9,10,12,13,14,16,17	
11	1,2,3,4,5,6,7,8,9,11,12,13,14,16,17,18	2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	2,3,4,5,6,7,8,9,11,12,13,14,16,17,18	
12	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17	
13	1,2,3,4,5,6,7,8,9,10,11,12,13,14,16,17,18	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,3,4,5,6,7,8,9,10,11,12,13,14,16,17,18	
14	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	
15	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	3,6,9,12,14,15,16,17	3,6,9,12,14,15,16,17	
16	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	
17	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	
18	1,2,3,4,5,6,7,8,9,11,12,13,14,16,17,18	1,2,3,4,5,6,7,8,9,10,11,13,14,15,16,17,18	1,2,3,4,5,6,7,8,9,11,12,13,14,16,17,18	*I*

The procedure of determination of hierarchies from transitive binary matrix by applying partitioning method is used iteratively and obtained Tables 5-10.

Table 6: Iteration 2

Code	Reachability	Attendance	Set Product	Level
1	1,5,6,8,12,13,14,16,17	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,5,6,8,12,13,14,16,17	II
5	1,5,8,11,12,13,14,16,17	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,5,8,11,12,13,14,16,17	II
6	1,5,6,8,10,11,12,13,14,15,16,17	1,3,6,7,8,9,10,11,12,13,14,15,16,17,18	1,6,8,10,11,12,13,14,15,16,17	
8	1,5,6,8,11,12,13,14,16,17	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,5,6,8,11,12,13,14,16,17	II
10	1,5,6,8,10,11,12,13,14,16,17	3,4,6,9,10,12,13,14,15,16,17	6,10,12,13,14,16,17	
11	1,5,6,8,11,12,13,14,16,17	2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	5,6,8,11,12,13,14,16,17	
12	1,5,6,8,10,11,12,13,14,15,16,17	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,5,6,8,10,11,12,13,14,15,16,17	II
13	1,5,6,8,10,11,12,13,14,16,17	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,5,6,8,10,11,12,13,14,16,17	II
14	1,5,6,8,10,11,12,13,14,15,16,17	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,5,6,8,10,11,12,13,14,15,16,17	II
15	1,5,6,8,10,11,12,13,14,15,16,17	3,6,9,12,14,15,16,17	6,12,14,15,16,17	
16	1,5,6,8,10,11,12,13,14,15,16,17	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,5,6,8,10,11,12,13,14,15,16,17	II
17	1,5,6,8,10,11,12,13,14,15,16,17	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	1,5,6,8,10,11,12,13,14,15,16,17	II

Table 7: Iteration 3

code	Reachability	Attendance	set product	Level
6	6,10,11,15	1,3,6,7,8,9,10,11,12,13,14,15,16,17,18	6,10,11,15	III
10	6,10,11	3,4,6,9,10,12,13,14,15,16,17	6,10	
11	6,11	2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	6,11	
15	6,10,11,15	3,6,9,12,14,15,16,17	6,15	

Table 8: Iteration 4

code	Reachability	Attendance	set product	Level
10	10,11	3,4,6,9,10,12,13,14,15,16,17	10	
11	11	2,3,4,5,6,7,8,9,10,11,12,13,1,15,16,17,18	11	IV
15	10,11,15	3,6,9,12,14,15,16,17	15	

Table 9: Iteration 5

code	Reachability	Attendance	set product	Level
10	10	3,4,6,9,10,12,13,14,15,16,17	10	V
15	10,15	3,6,9,12,14,15,16,17	15	

Table 10: Iteration 6

Code	Reachability	Attendance	set product	Level
15	15	3,6,9,12,14,15,16,17	15	VI

From the iterations contained in Tables 5-10 the conical matrix depicting ISM underlying model on diagonals is extracted that is converted in to digraph. Since conical matrix and digraph are optional in ISM procedure reporting from view point of brevity therefore have not been reported here as well. However ISM model is presented as Figure 1 below.

Results of ISM modeling show that consequences coded as (2), (3), (4), (7), (9), and (18), occupy *Level I.* Consequences codes as (1), (5), (8), (12), (13), (14), (16) and (17) occupy *Level II.* The consequence coded as (6) occupy *Level III*. The consequence coded as (11) occupy *Level IV*. The consequence coded as (10) occupy *Level V*. The consequence coded as (15) occupy *Level VI*.

Analysis: A 'Cross Impact Matrix Multiplication Applied to Classification' popularly known as MICMAC is performed to classify the consequences of floods in Pakistan. There are two common methods of MICMAC classification i.e. scale-centric and data-centric. The study performs both the two versions to have a deeper understanding of the phenomenon.

Scale-centric MICMAC Analysis: The scale centric MICMAC analysis is represented in Figure 2 below:

From Figure 2 it can be learned that i) the consequence of floods in Pakistan coded as 15 falls in the independent quadrant, ii) the consequences of floods in Pakistan coded as 2 and 10 falls in the dependent quadrant, and iii) the consequences of floods in Pakistan coded as 1, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 16, 17 and 18 fall in linkage quadrant. The autonomous quadrant is empty as there is no factor categorized in this quadrant.

Figure 1: ISM Model

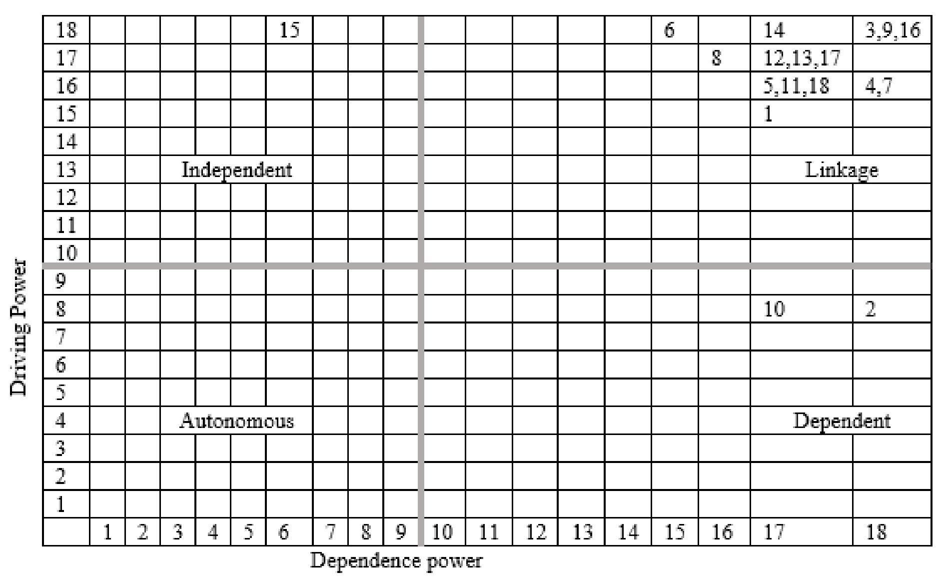
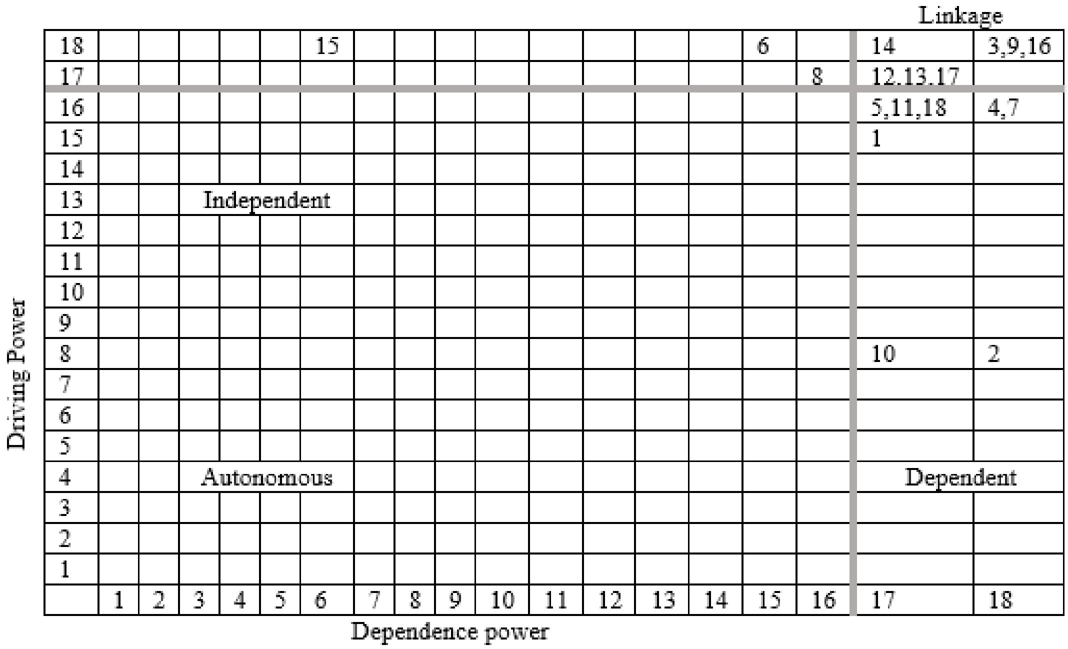


Figure 2: Scale-centric MICMAC Diagram

Data-centric MICMAC Analysis: The data-centric MICMAC analysis is represented in Figure 3 below:

Figure 3: Data-centric MICMAC Diagram



From Figure 2 it can be learned that i) the consequences of floods in Pakistan coded as 6, 8, and 15 fall in the independent quadrant, ii) the consequences of floods in Pakistan coded as 1, 2, 4, 5, 7, 10, 11 and 18 falls in the dependent quadrant, and iii) the consequences of floods in Pakistan coded as 3, 9, 12, 13, 14, 16, and 17 fall in linkage quadrant. The autonomous quadrant is empty as there is no factor categorized in this quadrant.

5. Results

The authors gathered series of: articles, research reports, statistical bulletins, year books, official documents from authoritative websites like google scholar, web of science, official websites of different relevant departments and institutions for literature discourse. Results of literature review show that there are total eighteen significant and major consequences of floods i.e. lost livelihoods of farmers (1), reduced food supply (2), destroyed crops (3), destroyed food stockpiles (4), destroyed livestock (5), destroyed seeds (6), destroyed infrastructures (7), destroyed equipment (8) economic strain on entire population (9), damaged and destroyed housing (10), displaced populations (11), injuries and deaths (12), disrupted schedules of transportation (15), inundate agricultural lands (14), spreading of waterborne diseases (15), reduction in soil fertility (16), increased prices (17), and disruption in trade & commerce (18). Results of ISM modeling show that consequences: reduced food supply (2), destroyed crops (3), destroyed food stockpiles (4), destroyed infrastructures (7), economic strain on entire population (9) and disruption in trade and commerce (18) occupy Level I. Consequences: lost livelihoods of farmers (1), destroyed livestock (5), destroyed equipment (8), injuries and deaths (12), disrupted schedules of transportation (13), inundate agricultural lands (14), reduction in soil fertility (16) and increased prices (17) occupy Level II. The consequence: destroyed seeds (6) occupy Level III. The consequence: displaced populations (11) occupy Level IV. The consequence: damaged and destroyed housing (10) occupy Level V. The consequence: spreading of waterborne diseases (15) occupy Level VI. Results of scale-centric MICMAC analysis show that: i) the consequence of floods in Pakistan coded as spreading of waterborne diseased (15) falls in the independent quadrant, ii) the consequences of floods in Pakistan coded as reduced food supply (2) and damaged and destroyed housing (10) falls in the dependent quadrant, and iii) the consequences of floods in Pakistan coded as lost livelihoods of farmers (1), destroyed crops (3), destroyed food stockpiles(4), destroyed livestock (5), destroyed seeds (6), destroyed infrastructures (7, destroyed equipment (8), economic strain on entire population (9), displaced populations (11, injuries and deaths (12), disrupted schedules of transportation (13), inundate agricultural lands (14), reduction in soil fertility (16), increased prices (17), and disruption in trade and commerce (18) fall in linkage quadrant. The autonomous quadrant is empty as there is no factor categorized in this quadrant. Results of data-centric MICMAC analysis show that: i) the consequences of floods in Pakistan coded as destroyed seeds (6), destroyed equipment, and spreading of waterborne diseased (15) fall in the independent quadrant, ii) the consequences of floods in Pakistan coded as lost livelihoods of farmers (1), reduced food supply (2), destroyed food stockpiles (4) destroyed livestock (5), destroyed infrastructures (7), damaged and destroyed housing (10), displaced populations (11), and disruption in trade and commerce (18) falls in the dependent quadrant, and iii) the consequences of floods in Pakistan coded as destroyed crops (3), economic strain on entire population (9), injuries and deaths (12), disrupted schedules of transportation (13), inundate agricultural lands (14), reduction in soil fertility (16), and increased prices (17) fall in linkage quadrant. The autonomous quadrant is empty as there is no factor categorized in this quadrant.

Table 11: Juxtaposed Results of Literature, MICMAC, and ISM

Results of Literature Review		Results of MICMAC Analysis					Results of ISM	
					Cluster			Comment
Code	Determinants	Driving	Dependence	Effectiveness	Scale-Centric	Data-Centric	Level	
1	Lost livelihoods of farmers	15	17	-2	Linkage	Dependent	*Level II*	
2	Reduced food supply	8	18	-10	Dependent	Dependent	*Level I*	
3	Destroyed crops	18	18	0	Linkage	Linkage	*Level I*	
4	Destroyed food stockpiles	16	18	-2	Linkage	Dependent	*Level II*	
5	Destroyed livestock	15	17	-2	Linkage	Linkage	*Level II*	
6	Destroyed seeds	18	15	3	Linkage	Independent	*Level III*	Critical Factor
7	Destroyed infrastructures	16	18	-2	Linkage	Dependent	*Level I*	
8	Destroyed equipment	16	17	-1	Linkage	Independent	*Level II*	Critical Factor
9	Economic strain on the entire population	18	18	0	Linkage	Linkage	*Level I*	
10	Damaged and destroyed housing	8	17	-9	Dependent	Dependent	*Level V*	
11	Displaced populations	16	17	-1	Linkage	Dependent	*Level IV*	
12	Injuries and deaths	17	17	0	Linkage	Linkage	*Level II*	
13	Disrupted schedules of transportation	17	17	0	Linkage	Linkage	*Level II*	
14	Inundate agricultural lands	18	17	1	Linkage	Linkage	*Level II*	
15	Spreading of waterborne diseased	18	6	12	Independent	Independent	*Level VI*	Key Factor
16	Reduction in soil fertility	18	18	0	Linkage	Linkage	*Level II*	
17	Increased prices	18	17	1	Linkage	Linkage	*Level II*	
18	Disruption in trade and commerce	16	17	-1	Linkage	Dependent	*Level I*	

Results of ISM modeling show that consequences coded as (2), (3), (4), (7), (9), and (18), occupy *Level I.* Consequences codes as (1), (5), (8), (12), (13), (14), (16) and (17) occupy *Level II.* The consequence coded as (6) occupy *Level III*. The consequence coded as (11) occupy *Level IV*. The consequence coded as (10) occupy *Level V*. The consequence coded as (15) occupy *Level VI*.

5.1. Discussion

Reiterating that the study aims to assess the severity of the consequences of floods in Pakistan, literature discourse, the collection of data from panel of experts and its modeling and analysis through structural techniques one can learn a lot from the findings. The literature discourse although not exhaustive but still give much depth and delivers a list of eighteen critical consequences of floods that detail of that is aforementioned in literature review section. The modeling technique has modeled the phenomenon (Figure 1) and depicted six structural levels, where the top level tells that the factors that inhibit at top level are dependent and considered as least critical. The consequences that inhibit at bottom level are the most critical and crucial and drive the whole phenomenon. The consequences that inhibit on the middle levels are linking and are moderate critical or severe according to the level they occupy. The key factors are that of bottom of the model (Table 11). The policy makers should address to the most critical factors and also take care of linking as the linking factors have the capability to affect others and in turn to themselves. The structural analysis of consequences in general corroborate the results of structural modeling. In the MICMAC analysis the factors are classified into four quadrants i.e. independent, dependent, linkage, and autonomous. The consequences that fall in independent quadrant have high driving power and relatively low dependence, therefore, they drive the counterparts, the consequences that fall in dependent quadrant have high dependence power and relatively low driving power, therefore, are driven by the counterparts. The consequences that fall in linkage quadrant are agile, unstable, unsettled, disconcerted, and swift need more care of the policy makers because if any action is taken on them affects all other factors and as a loop it mat affect themselves in turn as well. The factors that fall in autonomous quadrant are considered as disconnected from the phenomenon an should be eliminated from the system and if there is no factor in this quadrant, it is clear evidence of the fact the all the factors subject to analysis are very much integral part of the system and well deserve to be analyzed. In the current study there is no consequence in autonomous quadrant hence are the consequence are rightly made part of analysis. The MICMAC analysis is performed on both approaches i.e. scale-centric (Figure 2) and data-centric (Figure 3) and the results of the analysis are juxtaposed in eye-span (Table 11). Although there are many studies on consequences of floods in international context and in local contexts of Pakistan but since there could not be found any comprehensive study in this regard therefore the current study is justified and different from contemporary literature. It is also different from contemporary literature in data set used for analysis, approach, techniques of data collection, aggregation and analysis. It therefore produces different insights and sheds light on relations of consequences from very different perspective. The study has deep implications for the stakeholders of the phenomenon including national governments (i.e. policymakers/planners, project executors/plethora of departments and ministries, etc.), industry, landowners/farmers, the general public (households, local/village communities/community workers/labor, particularly disabled people, minorities, senior citizens and women), the scientific community, institutions responsible for disaster management, donors, academia, politicians/political parties, flood-prone-communities, NGOs/volunteers, and other affected like interested or vulnerable groups. Namely, social beneficiary group, non-social beneficiary group, socially adversely affected group, and non-social adversely affected groups. The study is highly beneficial to these groups, because it offers an understanding and comprehension of the situation on the ground, for framing policies, and implementing the systems. It helps the communities in being precautionary, vigilant, and helpful, and providing some solutions to the affected. It is also accommodating for developing a research framework for future studies. Findings also assist by offering deeper insights into the phenomenon. There are a few limitations of the study as well. Firstly, it is based on a small field survey for obtaining primary data i.e. survey of a medium-sized panel of experts that could be extended for optimum results. Secondly, it is subject to all the usual limitations of the qualitative type of study. Thirdly, the list of factors is not claimed to be comprehensive. Fourthly, the context of the study is Pakistan, therefore, the findings better explain the context of Pakistan. To overcome the limitations of this study future research may use TISM, Fuzzy ISM/TISM that has relatively greater interpretability. The consequences should be explored by using PCA or a rather thorough literature review to find other relevant factors/variables, and related interesting issues. An extensive survey should be conducted taking inputs from other stakeholders in the international context.

6. Conclusion

Floods are high-impact natural phenomena that have both positive and negative effects on lives, properties, businesses, livestock, crops, natural resources, infrastructure, wildlife, forests, and so on. Hardly any community, group, or thing is left that is not affected by floods. Therefore, it has a high degree of importance in the research agenda. Issue understudy 'consequences of floods' is related to it and hence very important. The study employed a qualitative design to address the issue. The overall design consists of a literature review, data collection, and analysis using literature discourse, ISM, and MICMAC analysis. Results of the literature review show that there are a total of eighteen significant consequences of floods i.e. Consequences coded as lost livelihoods of farmers (1), reduced food supply (2), destroyed crops (3), destroyed food stockpiles (4), destroyed livestock (5), destroyed seeds (6), destroyed infrastructures (7), destroyed equipment (8) economic strain on entire population (9), damaged and destroyed housing (10), displaced populations (11), injuries and deaths (12), disrupted schedules of transportation (15), inundate agricultural lands (14), spreading of waterborne diseases (15), reduction in soil fertility (16), increased prices (17), and disruption in trade & commerce (18).

Results of ISM modeling show that consequences coded as (2), (3), (4), (7), (9), and (18), occupy *Level I*. Consequences codes as (1), (5), (8), (12), (13), (14), (16) and (17) occupy *Level II*. The consequence coded as (6) occupies *Level III*. The consequence coded as (11) occupies *Level IV*. The consequence coded as (10) occupies *Level V*. The consequence coded as (15) occupies *Level VI*. Results of scale-centric MICMAC depict that: i) the consequence of floods in Pakistan coded as 15 falls in the independent quadrant, ii) the consequences of floods in Pakistan coded as 2 and 10 falls in the dependent quadrant, and iii) the consequences of floods in Pakistan coded as 1, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 16, 17 and 18 fall in linkage quadrant. The autonomous quadrant is empty as there is no factor categorized in this quadrant. Results of data-centric MICMAC depict that: i) the consequences of floods in Pakistan coded as 6, 8, and 15 fall in the independent quadrant, ii) the consequences of floods in Pakistan coded as 1, 2, 4, 5, 7, 10, 11 and 18 falls in the dependent quadrant, and iii) the consequences of floods in Pakistan coded as 3, 9, 12, 13, 14, 16, and 17 fall in linkage quadrant. The autonomous quadrant is empty as there is no factor categorized in this quadrant. The study has contributed a list of the severity of the consequences of floods, the ISM model, the scale-centric & data-centric MICMAC diagram like a Cartesian plane, and a set of inter-consequences relationships, inter-alia, a lot of information on level to level and at-level directional relationships making the structure of the phenomenon under study towards the contemporary body of knowledge.

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