Chapter -7

RESEARCH SUMMARY AND CONCLUSION

7.1 RESEARCH SUMMARY

7.2 CONCLUSION

7.3 RECOMMENDATION

7.1 RESEARCH SUMMARY

Flood is a geo-climatic and semi common risk with generally high stream which immerses the bank and upsets the characteristic assets alongside the anthropogenic properties. It can be assessed by ranking vulnerability which means judgment process to identify, predict, evaluate and justify the ecological, social and related biophysical effects of a flood on environment.

For the best possible comprehension of the current research problem, the author pursued a ton of Indian and Foreign journals, books, articles, research papers; newspapers etc. Present studies have considered stakeholder involvement to flood vulnerability assessments by multi-criteria decision-making (MCDM) techniques that are employed to aggregate various opinions and factors.

The flood in BTAD is a recurrent problem because the area is consist of multiple river basin upstream is from the high altitude Himalayan Bhutan hills and the river area has an ignorable gradients which creates a problem of stagnation of water and continuously erodes its banks thereby causing threat thousands of inhabitants and villages during the flood. The objectives of the present work are to assess the impact of flood vulnerability on the socio- economical and environment and the required management measures.

Kokrajhar region of BTAD is consider as the study area which is one of the most affected region which consists of three administrative sub-divisions, Kokrajhar, Gossaigaon and Parbathjhara, 9 no. of Circles, 11 no. of Blocks and around 941 villages.

The most common hydrologic vulnerability is watershed approach, the study a reach-based areal approach based on river reach is used. As per the geographical information the study area is divided into five sub- basin region as follows:

A1: (Champamati River basin) A2; (Gourang-Sharalbhanga River basin) A3: (Hel-Gongia River basin) A4: (Modati-Joyma-Tipkai River Basin A5: (Songkosh-Gadadhar River basin)

For the purpose of our study we have consider the following factors related to the flood problem such as environment factor, social factor and economic factors. For the simplicity of our study we have divided the main factors (criteria) into sub criteria as follows: five sub-criteria Rainstorm (C_{11}), Embankment Break (C_{12}), Drainage Density (C_{13}), Basin Area (C_{14}), Wetland (C_{15}) under environment factor, four sub-criteria Population growth (C_{21}), Population Density (C_{22}) , Housing Density (C_{23}), Industrial growth (C_{24}) under social factor and four sub-criteria Gross Domestic Product (C_{31}), Urban Area Ratio (C_{32}), Annual flood Damage (C_{33}), Annual flood Coverage (C_{34}) under economical factor are selected.

Fuzzy VIKOR method and OWA is used to identify the flood vulnerability which is ranking of the river basin area (Alternative) using the above mentioned sub criterion.

This criterions are grade in the form of linguistic variable Very High (VH), High (H), Medium High(MH), Medium(M), Medium Low(ML), Low(L), Very Low(VL) and the Trapezoidal fuzzy number as the fuzzy number. The experts opinion are collected from Sub Divisional Circle Officer (SDCO), one from District Disaster Management Authority (DDMA), two are executive Engineers under the water resource department one from relief and rehabilitation office and Assistant Professors.

The experts' opinions in the form of linguistic variable, Trapezoidal fuzzy number and its arithmetic operation are used to assess the rating of the weights for the established criteria. The individual opinions of the experts into group assessment are aggregated by using OWA operator and fuzzy VIKOR is used to rank the basin area alternatives.

The result shows that the alternative A1 -Sub basin1 (Champamati River basin) is the highest vulnerability in the criteria C11, alternative A2 -Sub basin2 (Gourang-Sharalbhanga River basin) is the highest vulnerability in the criteria C_{12}, C_{21}, C_{22}, C_{31}, C_{32}, The criteria C_{11} (Rainstorm) is the highest weights as per the experts followed by C_{12} (Embankment Break) and C_{33} (Annual flood Damage) respectively while criteria C_{24} (Industrial growth) has the least criteria weights.

The final score the alternative A5 (minimum of Q) that the Songkosh-Gadadhar river sub-basin is the most vulnerable region while A2 and A1 alternatives are second and third most vulnerability river basin region.

One of the most important aspects of flood management is flood control and flood damage reduction of river basin area. Flood control required hydrologic and hydraulic analysis of floods. This analysis determines inundated areas, flood elevation, and characteristics of required hydraulic structures for flood control or flood damage reduction.

A structural model of flood control project is considered in the chapter 5. The construction of flood control facilities can be referred as structural alternatives. In this study we consider four Alternatives: A1–**Dams and Reservoirs** (dams/reservoirs may be constructed across the upper stream of the river to store flood water), A2 – **Embankment and side Bands** (It is the oldest commonly used methods of protection against the floods), A3 –**De-silting and dredging** (improves the hydraulic capacity of channel can lower the water stage) and A4 – **Channel diversion** (An artificial channel can be used to divert the flood water). For ranking these alternatives four main criteria Ec: Economic, Sc: Social, Ev: Environmental and Tc: Technical and 12 sub criteria (Ec1: Cost of Project, Ec2: Implementation and maintenance, Ec3: Benefit of Project, Sc1: Effect on social fabric, Sc2: Perception of flood, Sc3: Recreation Ev1: Ecological Restoration,Ev2: Land Erosion ,Ev3: Water Quality, Tc1: Complexity of implementation, Tc2: Level of protection, Tc3: Complexity of maintenances) are included in the system. Fuzzy AHP Extent Analysis Method Chang (1996) method based on TFN is adopted to determine the weights of the criteria. We then used these weights to rank the best alternative by Fuzzy VIKOR method. A3 –**De-silting and dredging** is the most suitable structural flood control model followed by A1- Dams and Reservoirs

Towards the end this research presents the development and comparison of multiple MCDM technique such as Fuzzy PROMETHEE, Fuzzy VIKOR and Fuzzy TOPSIS to as-certain an accurateness of the method in the selection of best flood control alternatives.

7.2 CONCLUSION

The main purpose of this study was to present a framework for flood vulnerability modeling that relies the co design and cooperation between experts. This thesis used the MCDM method as a tool to assess the flood vulnerability river region.

The finding demonstrate the merits of vulnerability assessment by engaging experts in MCDM modeling process, including criteria selection, finding the weights and then rating the alternatives.

Next the study demonstrate structural flood control model considering the experts opinion on the selected criteria. The applicable best alternative selection depends on the expert's knowledge and expression.

It is trusted that the outcomes would give the administration, engineers, analysts, decision makers, and local authorities with a progressively suitable and invaluable guidance and outline for controlling the river basin on flooding, which is useful for managing flood Risk

7.3 RECOMMENDATION

It is possible to improve currently study by considering more and more criteria such as ecological factor, flood insurances criteria in social factor etc. this can increase the accuracy of the result.

It would be interesting to assess the future flood vulnerability study by considering climate change scenarios and future social projections. Most major urban cities in the world are expected to experience consequences of global warming in the form of more extreme rainfalls. Moreover, urban areas are expanding day-by-day, and social profile of the cities is changing rapidly. Therefore, future flood vulnerability predictions would provide significant contribution to the literature and study area.