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Guidelines for future community housing in flood prone areas of Kashmir

Ar. Hakim Ali Reza

School of Architecture & Design, Manipal University Jaipur, Rajasthan, India

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Abstract - *This research redefines vernacular housing typologies and landscape for natural disaster responsive urbanization of Kashmir. The paper gives an overview of all the major and minor changes during the evolution of Srinagar that have been causing floods in the past or are having a potential to do so in the future and also suggests guidelines to mitigate floods in existing as well as upcoming cities. The guidelines will be in the form of planning criteria for different layouts, use of new materials and adaptive building construction techniques which have been derived from the vernacular planning and architectural vocabulary to ensure social acceptance along with environmental sustainability.*

***Key Words*: Natural Disaster Responsive urbanization, Planning, Adaptive building construction techniques, Social Acceptance, Sustainability**

1.INTRODUCTION

The problems of Srinagar City and its environs constituting the metropolitan area are becoming more and more critical with the increased pace of urbanization causing population outburst and deterioration in existing level of services. The problems are assuming serious propositions in all aspect of urban living and are extremely critical in major sectors of sewerage, drainage, traffic and transportation, housing for urban poor and conservation of natural and cultural heritage. Adding to the chaos is the frequent flooding that brings the summer capital to a standstill.

J&K in India experienced one of the worst floods in the past 60 years, during first week of September 2014, due to unprecedented and intense rains affecting around 22 lac people all over the state. The satellite based rapid flood assessment report by collaboration of national Remote Sensing Centre (NRSC), Indian Space Research Organization (ISRO) and Department of Ecology, Environment and Remote Sensing (DEERS) revealed that the floods were a result of high rainfall in the catchments over short period of time, which were of the intensity of cloud bursts and a combined effect of the extreme event due to climate change and less capacity of the drainage system that failed to hold the quantum of water and it overflowed, which ultimately led to floods. Kashmir is now very vulnerable to flooding and experts point out that the beautiful valley in the Himalayas is flooding far too easily nowadays. Some causes, observations and impacts along with possible solutions are mentioned in the table below :

Table-1: Causes, observations, impacts and possible solutions to prevent and mitigate floods

Causes	Impacts	Observations	Solutions
Topography	Himalayan water tower consisting of glaciers, snow, rainfall & lakes/wetlands has high potential of flooding being hiked by increasing number and intensity of extreme storms because of climate change.	Many a times clouds entering into the valley are not able to escape because of high hills & go on accumulating & ultimately burst with high rainfall intensity sometimes more than 100 mm/hr.	
High groundwater level	Innumerable sources of water maintain a high water level to just 2'-3' below ground level in low lying areas like civil lines.	Extreme precipitation further raise ground water level reducing the already low water-soaking capacity of soil.	
Sole narrow outflow channel	Narrow gorge at Baramulla forming only outlet to a huge volume of water from various perennial sources controls and limits the outflow of Jhelum.	The narrow outlet at Baramulla can't take heavy outflow during floods and creates a back flow of flood waters hampering drainage.	
Location	City proper developed in and around areas which were either low lying or reclaimed marshes very close to Jhelum.	The city expanded into the wetlands that acted as sponges for flood waters	

Fig -1: Kashmir valley surrounded by mountains on all sides [1]

High river bed	Entire city of Srinagar is below Jhelum's high flood level (HFL). Even old city, which is comparatively higher than uptown Srinagar, is below HFL.	A blockade or breach anywhere along river or flood spill channel causes inundation.	

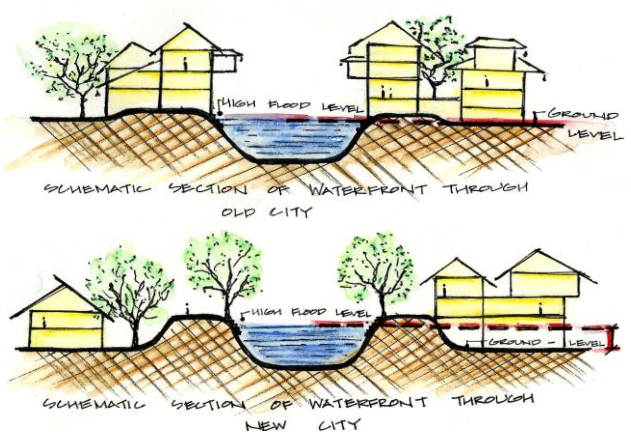

Fig -2: Schematic section showing difference between HFL & ground level in old & new settlements (Source: Author)

High run-off	The Kashmir region has recorded a 10% loss of its dense forest since 1992. Thus the ability of forests to retain water has been reduced causing more rain water to flow directly into Jhelum River causing flooding.	More than 90% of rain falling on hard and solid glaciers as well as rocks flows down as run-off. Incessant rains may also induce melting of glaciers and add to ferocity of floods.	
Barriers to water flow	Several barriers in the form of ill constructed bridges and encroachments choke the waterways & hamper the free flow of water delaying drainage as well as causing pollution.	There are at least 7old-fashioned & worn-out bridges which stay put even when they are not being used. Removing them would be very unethical although there is a need to remove numerous encroachments & newly constructed bridges over the river as well as the flood spill channel.	
Meandering course of Jhelum	Jhelum flows along a highly serpentine course creating loops, vulnerable to siltation and breaches, many of which exist inside the city.	Serpentine path of Jhelum reduces rate of flow of water & also increases pressure that water exerts on embankments especially at turning points.	**Straightening of the course :** Economically more viable than diverting which would cost around 8500 crores. Will reduce pressure on embankments & aid faster draining of water preventing threat of prolonged inundation to a great extent. Loops of the existing river could buy more time by being inundated first before other parts of the city get flooded and can also be developed into recreational areas for various water sports & other related tourist activities.

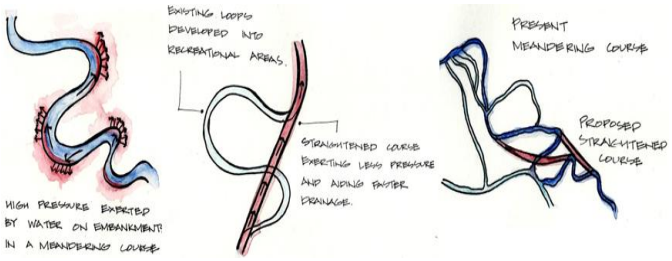

Fig -3: Conceptual sketches showing Straightening of Jhelum & its impact on the embankments (*Source: Author)*

Weak embankments	Though embankments along river are around 10-15 meters wide, but considering that they are earthen with just an inner stone lining on some stretches inside city that too done for riverfront beautification, these embankments are very vulnerable to breaches.	Embankments of Jhelum give in during heavy rainfalls causing sudden flooding of city, most of which lies below the HFL of Jhelum.	**Strengthening of embankments & constructing temporary embankments :** Strengthening of embankments using proper enduring materials & at places raising them so that low lying areas around them are safe. Protecting the historic riverfront architecture by guarding the heritage with removable embankment walls of precast concrete or steel panels. Also the *bunds* (embankments) (earthen ones) along *Nallas* (causeways) must be raised and strengthened as these low lying *bunds* are always prone to breach, and heavy losses are admitted through them.

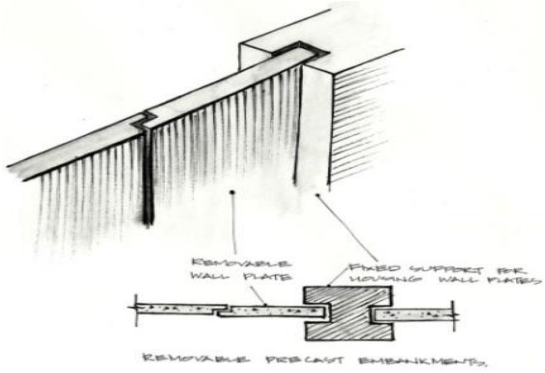

Fig -4: Conceptual construction of removable embankments *(Source: Author)*

Siltation	Tons of silt deposition has occurred in Jhelum due to rapid degradation of its catchments reducing the flood routing efficiency of Jhelum's outflow channel and its charge carrying	In absence of any conservation measures, Jhelum has lost around 43% of its carrying capacity causing blockage of its lone outflow channel in Baramulla, posing a risk of floods in	**De siltation :** Basic short-term measure for controlling floods. De-siltation in Valley Floor Lakes is required as rise & fall of level in these have a cause & effect

	capacity from 35000 cusecs in 1975 to 20000 cusecs at present.	valley.	relationship with discharge at point of outfall.
Filling up of waterways	Many side water canals, principally *Nallah Mar, Tsunt Kol* & *Rainawari*, used for transportation, also helped in draining low lying marshy areas of city. Introduction of motorized transport led to decline of traditional system of canal transportation and filling up of such canals.	Filling up of *Nallah Mar* in 1970's in a road-widening scheme cutting through much of the historical fiber of the city choked the canal systems and spelled ecological doom for *Brari Nambal* & *Khushal Sar* water lagoons.	**Restoring & upgrading channels :** Restoring the existing canals and flood spill channels. Improvement in flood channels to hold water beyond 35000 cusecs with current capacity of 15000 cusecs by a comprehensive de-siltation program would be economically viable too. The existing spill channel running across *Peerbagh* can be widened to receive the waters of *Doodhganga.* Feasibility study for digging an alternate flood channel of Jhelum from *Sanagam/Kandizal* to *Wular* should be carried out.
Change in land use/reclaiming water bodies & encroachment of wetlands	Urbanization sparked large scale migration causing encroachment over water bodies. Wetlands locally called *"Dembs"* that acted as sponges during the floods and shared the Jhelum waters, have been converted to built-up due to rapid urbanization. A research by J&K NSRC reveals loss of 50% of wetlands over 100 years.	Reclamation of land over most of water bodies has choked entire water system of city. Constructions along banks of Jhelum and elsewhere have strangulated natural drainage network & water gets stagnated in local depressions even if water level in Jhelum goes down & requires pumping out.	**Restoring wetlands :** Restoring wetlands that served as natural sponges during floods by removing encroachments & making existing natural drainage networks (inlets & outlets) viable for free flow of water. Revival of flood basin of *Khushalsar, Gilsar, Anchar, Hokharsar, Shalabugh, Haigam*.

Table -1.1: Extent of Lakes & wetlands in Kashmir valley (1911-2011) [2]

S.No.	Year	Category		Total [km²]
		Marshy	Water body	
1	1911	271.70	85.15	356.85
2	2011	117.43	41.11	158.54
Loss in spatial extent		154.27	44.04	198.31

Change in land use/reclaiming water bodies & encroachment of wetlands	Post-independence period saw advent of modern planning principles in city in stark contrast to vernacular ones. Most housing colonies built in & along floodplains of Jhelum stand regularized by governments thus encouraging conversion of remaining wetlands to built-up enclosures.	With most of natural sponges vanishing, the city faces problems of drainage & floods from rainfall because of excess water flow in Jhelum.	**New wetlands :** Preventive measures for safeguarding low lying areas of the city like *Natipora, Rambagh, Lasjan, Mehjoornagar, Kursoo, Padshahibagh, Bemina*, etc. which comprised the former wetlands must be taken.
	Construction of communication network & other developmental activities associated with land use change add to vulnerability.		
	significant land use change to Built-up by about 30% in extent within 10 km buffer of Srinagar (DEERS) from 1964 to 2012.	Floods caused extensive damage not only in villages but even in city areas that were previously part of flood plain of Jhelum as they fell outside municipal limits in past.	**New wetlands :** With the city having sprawled beyond bye-pass road, flood plains of Jhelum must also be shifted southwards

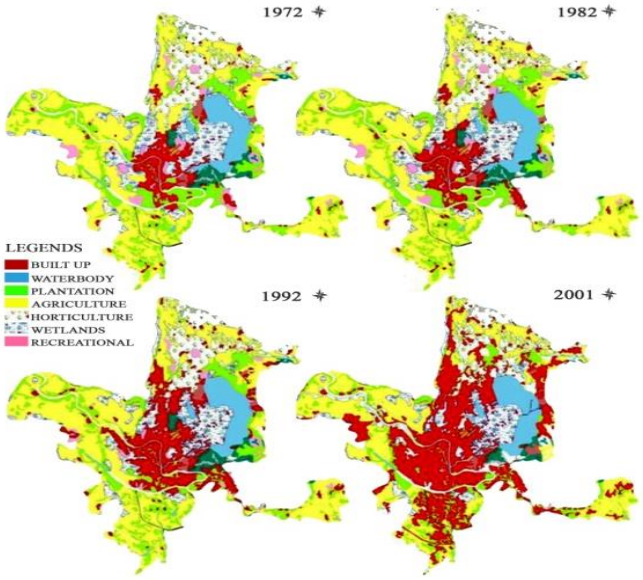

Fig -5: Maps showing land use changes in Srinagar (1972-2001) [3]

Insufficient flood control infrastructure & lack of action	Flood control infrastructure has lost its former capacity to hold & carry water. Prevailing condition suggests that it can crumble even under less than 40,000 cusec of water. Before Sept. 2014 floods, carrying capacity of Jhelum & flood spill channel, as per I&FC department, was 43,000 cusec. State is facing economic constraints & political disturbance.	Many areas of Srinagar including most of civil lines were submerged for around a month waiting for external help during September 2014 floods Several breaches along Jhelum & its flood channel have not been plugged properly rendering bunds weak to counter the pressure of flood waters making Srinagar vulnerable.	**Institutionalizing disaster management :** Setting up of State Disaster Management Authority (SDMA) having clear mandate to build capacity of state to prepare for, protect against, respond to, recover from, and mitigate all types of hazards. Developing flood risk/hazard zonation map. Monitoring of sediment loads from catchments & land use of river basin. River monitoring & flood fore-warning system. Regulations to check future interferences with drainage system & conduct river training works to minimize

			infrastructural damages & human miseries.
Climate change	The climate of the state has changed due to the global warming which is causing more of the glaciers to melt. Report by NRSC, ISRO and DEERS revealed that 2014 floods were a result of high rainfall of intensity of cloud bursts and a combined effect of climate change & less capacity of drainage system.	Incidents of cloudbursts have increased manifold. By 2030's intensity of rainy days will increases in a more warming scenario. The number of rainy days in eastern J&K will increase by more than 15 days in 2030's . Intensity of rainfall is likely to increase by 1-2mm/day (Indian Network on Climate Change Assessment, 2010). Annual rainfall in some areas of J&K will increase up to 50%. (State Action Plan on Climate Change, 2013).	**Adaptation :** All the new construction must adapt to the changing scenario in terms of materials used, construction techniques as well as planning e.g., reversing the traditional planning by placing the storage spaces, halls and guest room etc. on ground floor and shifting the kitchen and living areas on to the first floor can help in floods by preventing the inundation of living spaces.

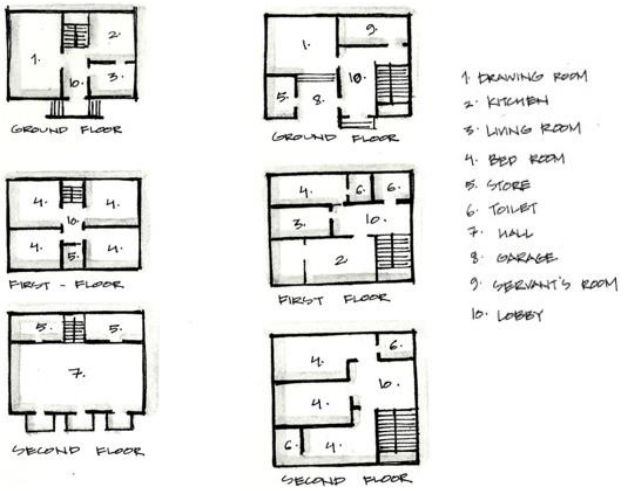

Fig -6: Traditional planning v/s flood adaptive planning *(Source: Author)*

2.MACRO LEVEL PLANNING

2.1 Planning criteria

The concept has been derived after taking into consideration the physical, economic as well as the socio cultural needs of the people as all of them have a role in upholding and leading the intangible heritage of the culture and traditions that provide an identity to a society.

Socio cultural criteria:

From historical references, it is evident that throughout the evolution of the Srinagar city, the basic physical and social unit of the settlement remained the *mohalla*. In most cases, the *mohalla* or a part of the *mohalla* would be occupied by members of the same family or community. An individual *mohalla* would usually comprise thirty or more residential units with an associated mosque or temple. This setup promoted community level socialization and interaction. Also the *mohallas* comprise multi storey dwellings (generally G+2) per household the trend of which still continues.

Physical criteria:

The present trend of each household having a private garden contributes largely to the urban sprawl as a huge chunk of land is owned by a single household. The average land owned by a typical household in Srinagar measures around one *kanal* (5445 sq. ft.). The present land crisis cannot provide for and sustain such practices, thus making the traditional *mohalla* concept that provided shared open community spaces apt for the future settlements.

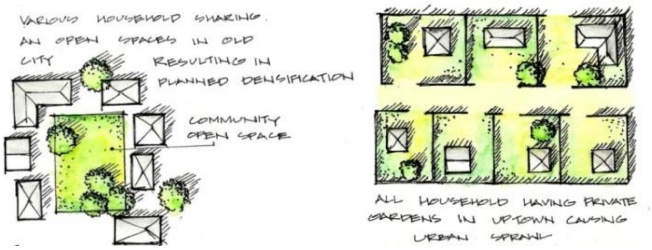

Fig -7: Contrasting neighborhood layouts in old & new city on right & left banks of river Jhelum *(Source: Author)*

Economic criteria:

The private garden concept adds to the land requirements which in turn further escalates the cost that would make the scheme unaffordable. The mohalla concept, by providing common open spaces reduces the land requirements per household thus cutting down the total cost. This further if subsidized by the Government would make the scheme affordable to the masses.

Thus, a scheme designed using the concept of mohalla as a guide could help in reviving and enhancing the social traditions and cultural values that are being somewhere lost in the process of urbanization.

2.2 Site layout

The layout of the settlement unit has been developed on the concept of the traditional *mohalla*, which after natural physical features formed the most important determinant in shaping the city of Srinagar. A typical unit comprises of a cluster of houses with a common open space that would be shared by all providing for socialization. The whole scheme would comprise of similar clusters with more lavish open spaces between the clusters to further enhance community interaction and create a hierarchy of spaces. Also, the whole setup would be dotted by spaces associated to commercial, religious, recreational, and other required public facilities. Such settlements could be a terraced development on higher

grounds within or very near to the city the built example of which, Pari Mahal- the terraced Mughal garden, already exists in Srinagar.

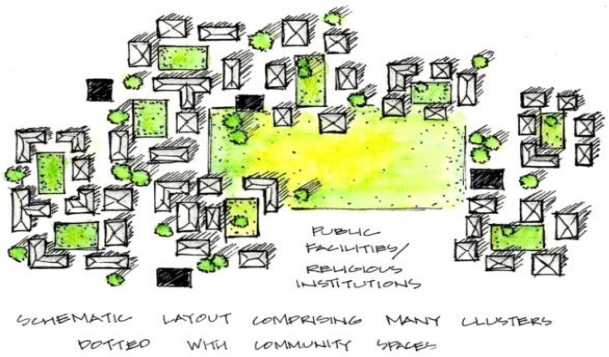

Fig -8: Schematic layout comprising many clusters dotted with community spaces *(Source: Author)*

Such schemes could be developed in Srinagar and other districts too after identifying proper sites for their development.

3. MICRO LEVEL DESIGNING

3.1 Design criteria

The design derives its inspiration from the vernacular architecture that in addition to culture and climate, responds flawlessly to the natural calamities.

Response to earthquake:

Srinagar being in the earthquake Zone 5 suffering earthquakes of intensity MSK IX or greater, the vernacular architecture has responded through techniques such as extensive use of wood especially on upper levels for light construction with cantilevered projections of floor beams called *dubb* for dampening earthquake vibrations. The traditional practice has been to construct load bearing walls using masonry and wood in *taaq* or *dhajji deewari* construction styles, where the wooden braces forming the frame are infilled with brick or stone and then plastered. The wood provides flexibility to the walls allowing their bending during earthquakes without collapsing but such walls may yield during floods.

Fig -9: House in Kashmir damaged in 2005 earthquake showing how unreinforced masonry collapsed, leaving the top story of *Dhajji Deewari* in place. [4]

Response to flood:

Massive masonry walls usually of stone till one floor followed by brick walls reducing in thickness on successive floors in addition to being earthquake responsive also could resist the pressure exerted by water during floods.

Fig -10: The upper floors of a heritage structure raised to ground during 2014 floods with its massive base intact [5]

3.2 Design characteristics

The design of the new structures in the disaster-prone sites is governed by the site characteristics as well as their response to any natural calamity. Apart from being earthquake and flood responsive some of the characteristics are listed below

Flood resilience:

The new structures in flood prone areas in addition to not collapsing on occasion of flooding can help sustain the inhabitants within their own houses till the time some kind of help reaches which sometimes may take weeks. This is achieved by reversing the traditional planning by placing storage spaces, halls, and guest rooms etc. on ground floor and shifting the living spaces and kitchen to the first floor to prevent the inundation of these essential spaces thus helping to sustain life during any such tragedies. Considering that the flood waters in some areas can reach a height of up to 18 feet, high plinths won't facilitate the house to be functional when being inundated.

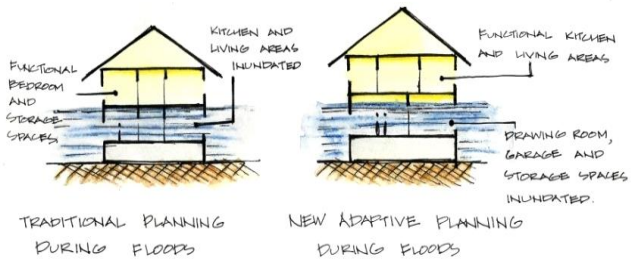

Fig -11: Flood resilient planning of spaces (Source: Author)

Response to vernacular architecture:

History is witness to the fact that any constructions having an architectural vocabulary alien to vernacular one have failed to persist and have been abandoned by the local population. Thus, to ensure local acceptance, the new

constructions must be in line with the vernacular architecture which can be achieved by strict elevational controls and by laws. For this purpose, separate guidelines could be laid and new rules framed and imposed.

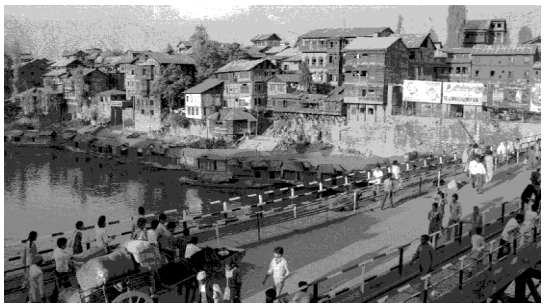

Fig -12: Vernacular style architecture along Jhelum riverfront from *habba kadal* - a model for new constructions [6]

4. DESIGN STRATEGY

Conventionally the effort should be to keep the structure as light and flexible as possible in response to earthquakes and heavy in response to floods. Thus, to achieve the required balanced combination of both the schemes, the lower part of the structure that actually counters the force exerted by the flood waters could be made massive while the upper part that is most affected by the earthquakes could be made light. This calls for the materials to be chosen accordingly taking into account their strength and durability and also the availability, cost effectiveness and environment friendliness.

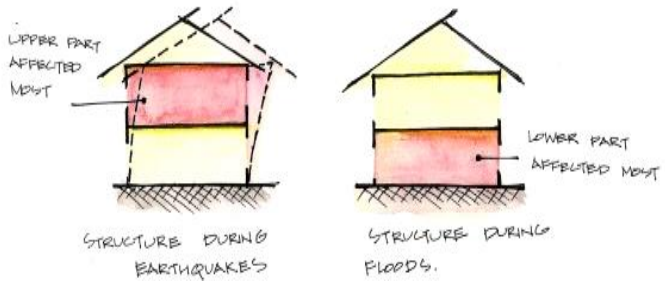

Fig -13: Response of structures to earthquakes and floods *(Source: Author)*

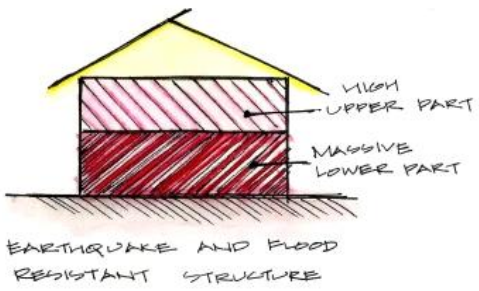

Fig -14: Ideal earthquake and flood responsive construction strategy *(Source: Author)*

5. BUILDING CONSTRUCTION AND MATERIALS

The structure should be a frame construction since it acts as a single element once the construction is complete with walls and roof. Also, it has altogether better consistency than the post and beam construction and marvelous suppleness due to its multi-articulated construction pertinent for earthquakes [7].

Foundation:

Anchoring provided by the concrete footings being much stronger than the traditional stone stepped footings could be used to replace the traditional style and materials for laying foundations.

Envelope:

The present constructions don't integrate wood into structural members and complete load bearing brick walls are being constructed. Considering the strength and flexibility that concrete frame constructions exhibit, they can be used to replace the massive *taaq* wall construction on ground floor to resist pressure exerted by water with upper floors being constructed in traditional light weight *dhajji deewari* style for earthquake response. The masonry infill could be put together in a basket weave pattern, so that any movement of earth would have a tendency to lock them more tightly into place and thus increase the solidity of masonry work.

Fig -15: A traditional house combining *taaq* system of construction on lower floors followed by *dhajji deewari* on upper ones with *dubbs* projecting out [8]

Floor:

Traditionally the floors comprise of wooden beams supporting rafters and wood planks over which sometimes screed covered by tiles is laid. This practice makes the structure light weight and earthquake resistant but causes cracks after floods due to expansion of wood when immersed in water and its contraction when the water recedes. Thus, the first slab could be cast in concrete which doesn't expand or contract when in contact with water, followed by traditional floor system on the adjacent storey's.

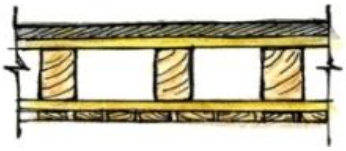

Fig -16: Traditional wooden ceilings expand during flood & contract afterwards causing walls to crack (Source: Author)

Roof:

The pitched roof could be wooden skeleton covered by tin sheets with low pitch to help accumulate snow in winters that after sometime builds up a cozy blanket offering a powerful insulation against cold.

Fig -17: A traditional house having wooden doors, windows and pitched roof for light weight [9]

Fenestrations:

The traditional practice of making wooden doors and windows between two *taaq* (piers) allows for proper load transfer and can be continued as it is.

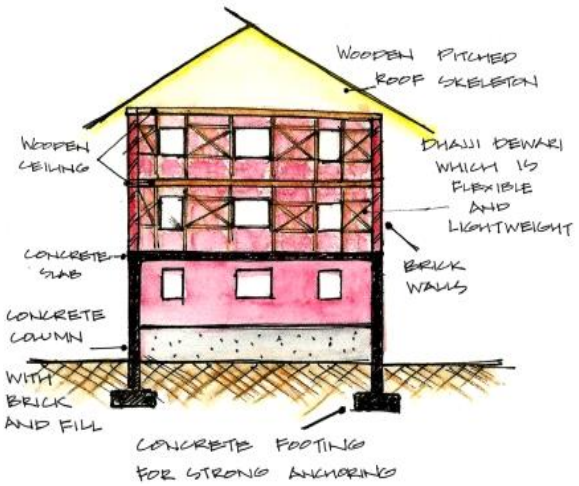

Fig -18: Schematic section showing mix of modern and traditional construction techniques for new constructions *(Source: Author)*

6. CONCLUSION

The floods in the valley apart from innumerable man made factors are a result of the climate change in a broader perspective. Working towards the revival of the natural water systems that once existed as well as protection of the threatened ones is the need of the hour. In addition to this, adapting the construction styles according to the change in climate and rainfall patterns that are inevitable in future is also required to prevent the loss of lives in any such future hazards and protect the fragile heritage of the Paradise on Earth. The proposed scheme would be embraced by its prime stakeholders as it would promote the ancient cultural and social values that people have evolved with and adapted to over years rather than putting them in an alien setting. Thus, it would help to sustain the social traditions and cultural heritage in an absolutely new setup by holding on to the roots.

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BIOGRAPHY

Hakim Ali Reza is a fresh graduate architect having a keen interest in traditional Kashmiri craft & vernacular architecture. Having worked at offices like Min2 Bouw-Kunst B.V. Netherlands, INTACH Kashmir chapter & Architects Combine Srinagar, he is currently working with Craft Development Institute, Srinagar on various projects for amalgamating traditional crafts with modern architectural practices.