Courting Catastrophes from hill torrents through adaptation in changing climate

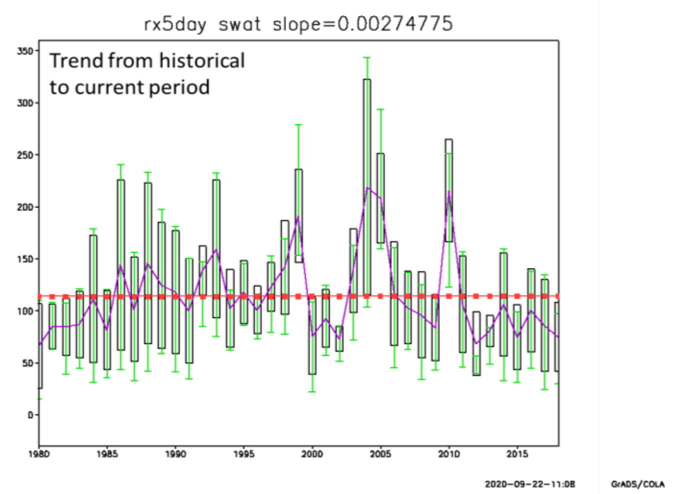
Case study of Swat, KPK

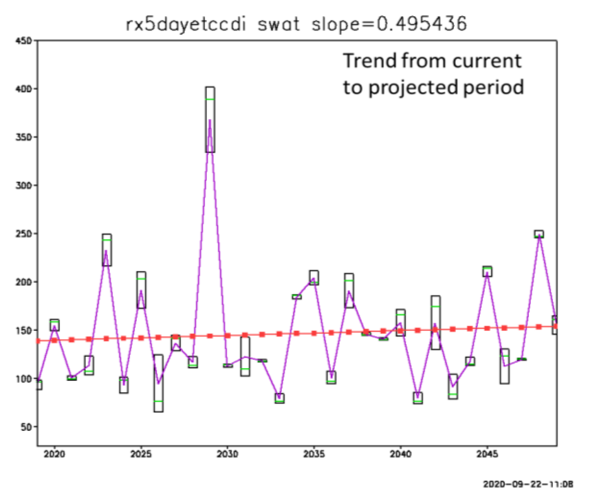
Summary:

The three consecutive days very heavy rain spell in the Swat region during last week of August 2020 was one of the major key role player in deteriorating impacts induced by climate change in the region. At least 40 houses swept into the torrent after River Swat overflowed into Madyan. The flash flood occurred following heavy rains in the area including Malam Jabba, Dir, Madain, Bahrain and Kalam which were also cut off from the rest of the region after floods water washed away 12 bridges connecting the areas.

Over the years it is seen that western regions of the KPK province have experienced and shall be prone to extreme warming with up to 2°C increase in maximum temperature by next 25 years in a carbon forced climate. According to Clausius–Clapeyron relation, moisture holding capacity of the atmosphere increases by 7% when temperature is increased by 1°C. Therefore, moisture holding capacity of Swat region is susceptible to increase by a whopping 14% which would be liable to constrain voluminous amount of additional vapour. That vapour when met with favourable atmospheric cooling conditions would have potential to generate extreme rainfall events in smaller duration of time and may cause devastating flash floods in the region.

To address such extreme regimes over the Swat region, amount of heavy precipitation that occurs in 5 consecutive days (RX5day) over the historical and the projected periods have been analysed. Results depict that historical trend of RX5day remains consistent in the current period which endorses the returning cycles of the rain extremes to recur over time



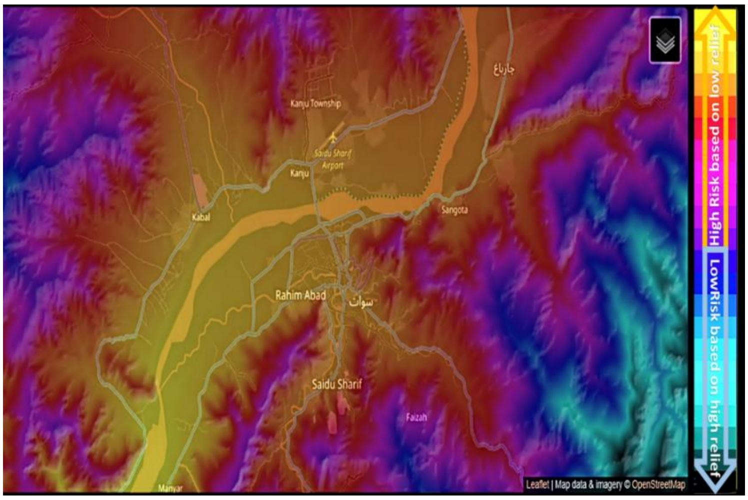


(as seen that the catastrophe of 2010 returned in 2020 over Swat region). In the projections, the trends show severe impacts with 15 mm added precipitation amount in 5 consecutive days by the year 2050. Another such wave in 2029-2030 is also indicated by the climate forced models which establishes that such events are periodic over Swat with a return period on decadal scale.

The economic and human toll of the disaster continue to grow since the catastrophe took place. It is reported that The floods have left 142 dead in Swat and hundreds of thousands without homes, food, electricity or clean water. The surging water has knocked down mud-walled houses, apple orchards, fish genesis ponds, cattle, and has ruined reserves of staple crops in the region. Moreover, Electrical towers have been washed away, leaving behind crumpled steel skeletons and broken high-tension wires. Deployment of concrete reinforcements need to be promoted for mitigating impacts of climate extremes.

Flood modelling of Swat river

By deploying river flood modelling over Swat region, it is established that in case of a hill torrent, more water will gush form North to South and the southern slopes of the Swat region will be more vulnerable. The flood modelling further shows that spatial expanse of the flood water inundation from a hill torrent can protrude up to 500 m on either side of the river. It is also seen that the flood water will also intrude in to the residential premises and will make livelihood more vulnerable if such environmental conditions recur.



Current mitigation practices

Current practice of retaining flood water from hill torrents in Swat rests solely on non-geometrical boulders installed on peripherals of the valley. It is to be noted that in case of extreme flood due to hill torrent, such flood water retaining methods pose more of a risk than help control the incoming flow. The fragilely placed boulders, in such environments, augments severity by contributing small and big shards in to the flood water. Hence, such methods of adaptation shall only add to the misery of the already devastated region than do may help. Below image is such an example where non geometric rock boulders have been placed to prevent high magnitude flows from hill torrents in the Swat valley.

However as seen in the post flood disaster image, the retaining boulders have slid down along the flood torrent and has done more harm than good in the region.

<u>Proposed adaptation (Concrete Rockfall Embankments)</u>

Concrete based rockfall protection embankments are passive systems and an ideal solution when surface stabilisation systems cannot be installed (e.g. for very wide slopes) or where interception of falling rocks is not possible due to the whole slope being inaccessible. They are commonly used as protection from natural hazards, landslides, rockfalls, avalanches, hydro-geologic problems and more.

Rockfall protection embankments are built using reinforced concrete, enabling engineers to use locally available site-won materials. Face finishes may include a vegetated embankment front, which reduces the environmental and visual impact of the system.

There is a reduced need for repair with almost unlimited potential. Being constructed from reinforced concrete, rockfall embankments are scalable to accommodate extreme rockfall impacts (potentially up to 20,000kJ) and also to divert potential debris flows. Unlike rockfall catch fences, rockfall embankments can sustain multiple impacts and rockfall events without the need for repair. Given enough space, almost unlimited energy absorption capacities are achievable. An example of such concrete reinforcement that can be deployed in Swat in shown in picture.