Physical, social and institutional vulnerability assessment in small Alpine communities. Results of the SAMCO-ANR project in the Upper Guil Valley (French Southern Alps)

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The Guille catchment is particularly prone to torrential and gravitational hazards such as floods, debris flows, landslides or avalanches due to several predisposing factors (bedrock, supply of abundant debris, strong hilly-loop-channel connectivity) in a context of summer Mediterranean rains storms as triggers. Since the second half of the 20th century, the progressive decline of agrarianism and the development of tourism activities led to a concentration of human stakes on alluvial cones and valley bottoms; therefore an increase of vulnerability for mountainous communities. Following the 1957 and 2000 catastrophic floods and the 1948 and 2008 avalanche episodes, some measures were taken to reduce exposure to risks (engineering works, standards of construction, rescue training...). Nevertheless, in front of urban expansion (land pressures and political pressure) and obsolescence of the existing protective measures, it is essential to reassess the vulnerability of the stakes exposed to hazards. In the frame of the SAMCO project designed for mountain risk assessment in a context of global change, different maps for summer and winter periods, assessed the stakes exposed to hazards in our context (Fig. 1). In the frame of the SAMCO project designed for mountain risk assessment, we developed a systemic approach to assess three specific components of vulnerability: physical, social and institutional, for the six municipalities of the upper Guille catchment (Ristolas, Abriès, Aiguilles, Château-Ville-Veillou, Moirans-en-Queyras and St-Véran (Fig. 1). This work remains part of a large study on risk in mountainous region that would lead to a web demonstrator intended for risk stakeholders. We expect that those new results on vulnerability will contribute to a better assessment of the global vulnerability of the upper Queyras region to hydrogeological hazards. This work must help the development of better land use and could be used to help local authorities to improve and update their Emergency Action Plan on their Prevention Plan. The next step of this work will be to try to elaborate a method combining these maps to produce a global risk map for mountain risks.

1- Background

The physical vulnerability assessment was quantified using a GIS model from Potential Damage Index (PDI) (Fig. 2). This index allows us to quantify and describe both direct - physical injury, structural and functional impacts - and indirect consequences - socio-economic impacts - induced by hazards; this by combining weighted parameters reflecting the exposure of elements at risk, buildings, networks and land cover (Fig. 3). At least 1890 buildings, 367 km of land cover and 932 km² of network were considered. Vulnerability maps were then crossed to hazard map reflecting different scenarios of exposure. To take into account the temporal variability of vulnerability, we produced different maps for summer and winter periods. To assess social and institutional vulnerability we realized questionnaires and interviews assessing stakeholders perception, mitigation measures and confidence in the actors of risk management.

3- Results: Physical vulnerability assessment

Potential structural and functional vulnerability map for flooding (Fig. 5) put forward urbanized and cultural space. Physical vulnerability (i.e. total potential consequences of hazards on stakes) was estimated and mapped via GIS model from Potential Damage Index (PDI) (Fig. 2). This index allowed us to quantify and describe both direct - physical injury, structural and functional impacts - and indirect consequences - socio-economic impacts - induced by hazards; this by combining weighted parameters reflecting the exposure of elements at risk, buildings, networks and land cover (Fig. 3). At least 1890 buildings, 367 km of land cover and 932 km² of network were considered. Vulnerability maps were then crossed to hazard map reflecting different scenarios of exposure. To take into account the temporal variability of vulnerability, we produced different maps for summer and winter periods. To assess social and institutional vulnerability we realized questionnaires and interviews assessing stakeholders perception, mitigation measures and confidence in the actors of risk management.

4- Results: Social and institutional vulnerability assessment

Potential structural and functional vulnerability map for flooding (Fig. 5) put forward urbanized and cultural space. Physical vulnerability (i.e. total potential consequences of hazards on stakes) was estimated and mapped via GIS model from Potential Damage Index (PDI) (Fig. 2). This index allowed us to quantify and describe both direct - physical injury, structural and functional impacts - and indirect consequences - socio-economic impacts - induced by hazards; this by combining weighted parameters reflecting the exposure of elements at risk, buildings, networks and land cover (Fig. 3). At least 1890 buildings, 367 km of land cover and 932 km² of network were considered. Vulnerability maps were then crossed to hazard map reflecting different scenarios of exposure. To take into account the temporal variability of vulnerability, we produced different maps for summer and winter periods. To assess social and institutional vulnerability we realized questionnaires and interviews assessing stakeholders perception, mitigation measures and confidence in the actors of risk management.

5- Conclusion

The Guille catchment is particularly prone to torrential and gravitational hazards such as floods, debris flows, landslides or avalanches due to several predisposing factors (bedrock, supply of abundant debris, strong hilly-loop-channel connectivity) in a context of summer Mediterranean rains storms as triggers. Since the second half of the 20th century, the progressive decline of agrarianism and the development of tourism activities led to a concentration of human stakes on alluvial cones and valley bottoms; therefore an increase of vulnerability for mountainous communities. Following the 1957 and 2000 catastrophic floods and the 1948 and 2008 avalanche episodes, some measures were taken to reduce exposure to risks (engineering works, standards of construction, rescue training...). Nevertheless, in front of urban expansion (land pressures and political pressure) and obsolescence of the existing protective measures, it is essential to reassess the vulnerability of the stakes exposed to hazards. In the frame of the SAMCO project designed for mountain risk assessment in a context of global change, different maps for summer and winter periods, assessed the stakes exposed to hazards in our context (Fig. 1). In the frame of the SAMCO project designed for mountain risk assessment, we developed a systemic approach to assess three specific components of vulnerability: physical, social and institutional, for the six municipalities of the upper Guille catchment (Ristolas, Abriès, Aiguilles, Château-Ville-Veillou, Moirans-en-Queyras and St-Véran (Fig. 1). This work remains part of a large study on risk in mountainous region that would lead to a web demonstrator intended for risk stakeholders. We expect that those new results on vulnerability will contribute to a better assessment of the global vulnerability of the upper Queyras region to hydrogeological hazards. This work must help the development of better land use and could be used to help local authorities to improve and update their Emergency Action Plan on their Prevention Plan. The next step of this work will be to try to elaborate a method combining these maps to produce a global risk map for mountain risks.