A quarter of the world's lowland population depends critically on mountain water resources

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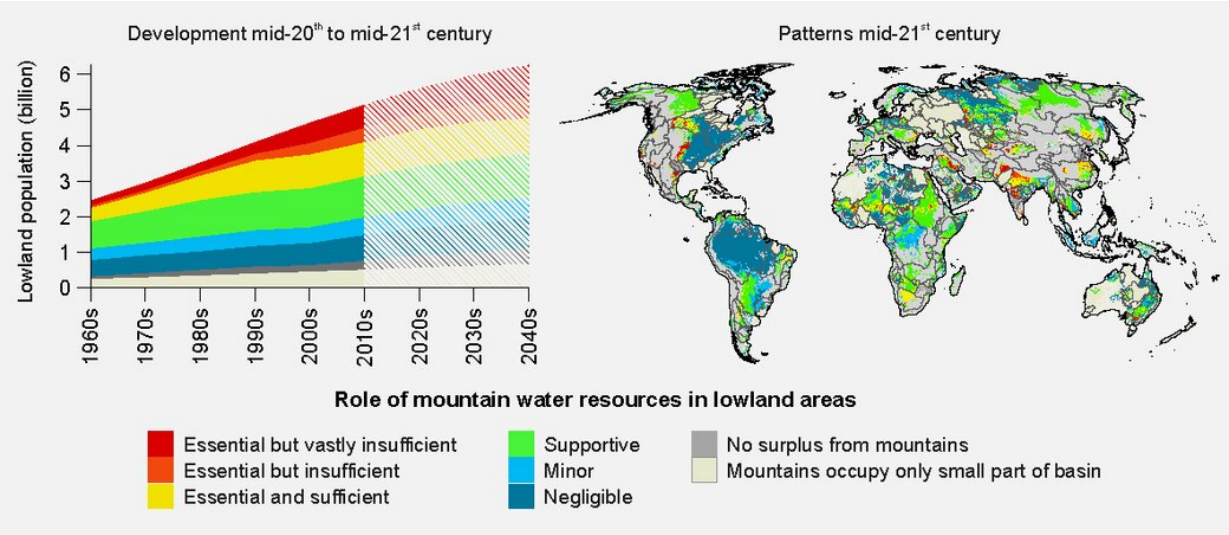
Mountains are important "Water Towers". This is the Rosegbach River in Switzerland, part of the Danube river basin where a third of the 46 million people living downstream strongly depend on water resources from mountain areas. Credit: D. Viviroli

Global water consumption has increased almost fourfold in the past 100 years, and many regions can only meet their water demand thanks to essential contributions from mountain regions. By the middle of this century, 1.5 billion people, almost a quarter of the world's lowland

population, will strongly depend on runoff from mountain regions. Only sustainable development can ensure the important function of mountains areas as Earth's "water towers" in the future.

Water is a key resource for the twenty-first century, and many lowland regions depend on water resources originating in mountain regions, not least for strongly expanded irrigation of agricultural land. A study just published in *Nature Sustainability* led by the University of Zurich quantifies this dependence for the first time by comparing water supply and consumption in the world's lowland areas with runoff contributions from the mountains. Based on a high-resolution global model, the study provides detailed information on the dependence on mountain water resources for each grid cell of five arc minutes (~9 km at the equator). This allows for highly differentiated insights into regional characteristics and differences.

"Until now, research has focused mainly on river basins that originate in High Mountain Asia," says Daniel Viviroli from the Department of Geography at the University of Zurich, first author of the study. "But in many other regions, irrigated agriculture is heavily dependent on water from mountainous areas, such as in the Middle East and North Africa, as well as parts of North America, South America and Australia."



The role of mountain water by 2050 in the water resources of lowland countries. Credit: D. Viviroli

This dependence has increased strongly since the 1960s—despite more efficient water use and thus declining per-capita water consumption. Whereas only 7 percent of the lowland population was strongly dependent on contributions of mountain areas at that time, this figure is projected to rise to 24 percent (1.5 billion people) by mid-twenty-first century. For their analyses, the researchers assumed a "middle of the road" scenario in terms of population growth as well as technological, economic and social development.

"Ensuring the function of mountains as 'water towers' should be a major concern of the world's lowland populations," says Associate professor Matti Kummu from Aalto University, who was part of the study team together with Ph.D. researcher Marko Kallio. Sustainable development of mountain regions is therefore essential, for example by preventing agricultural overuse and ensuring the functioning of ecosystems. In addition, climate action is of paramount importance: due to rising

temperatures, meltwater peaks from the mountains already occur sometimes several weeks earlier and thus arrive at a less favorable time for agriculture.

Adjustments in water management will be necessary, and possibly also new infrastructure such as dams and water transfers. "However, technical solutions go hand in hand with major ecological damage, and some rivers, such as the Indus, have little potential for expansion" says Viviroli. For the future it will be crucial that lowland and mountain regions work closely together despite cultural, social and economic differences.

More information: Daniel Viviroli et al. Increasing dependence of lowland populations on mountain water resources, *Nature Sustainability* (2020). DOI: 10.1038/s41893-020-0559-9

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