

ANNEX 1: ALPINE REGION

Annex present main features of Alpine region and problem of sewage sludge.

1.1 About Alpine region

Alpine environments are cold, windy, and snowy, characterized by low growing season temperatures and a short frost-free period. Within the EU, five of the highest ranges (Alps, Apennines, Pyrenees, Scandes, Carpathians) have been included in the Alpine biogeographic region, which is 7,6 % of the EU (28) territory. They all are characterised by a relatively cold and harsh climate, high altitudes, and an often complex, varied topography. Because of their steep gradients, mountains have highly compressed latitudinal life zones. As a result, habitats and species alter rapidly with altitude. The complex topography and differing exposures also create a myriad of different micro-climates.

Most mountain ranges are poorly populated in terms of human land-use and impacts, particularly above 1.000 m (or 500 m in the case of the Scandes) due to the harsh climate, difficult access, and short growing seasons. Traditional pastoral farming practices are rapidly disappearing under the combined pressure of land abandonment and intensification. Other more recent activities, such as mass tourism, large-scale afforestation and deforestation, the damming and channeling of alpine rivers, and the construction of roads, also impact this particularly fragile environment. Climate change presents another major threat. Because of the tight ecological and climatic bands in the mountains, a small change could have devastating effects on their ability to absorb and retain water¹.

Alpine ecosystems were identified early on as potentially susceptible areas. However, as the frequency distribution of additional physiographic factors (e.g., slope angle) changes with increasing elevation (e.g., with few gentle slopes available at higher elevation), species migrating upslope may encounter increasingly unsuitable conditions. As a result, many species could suffer a severe reduction of their habitat surface, which could, in turn, affect patterns of biodiversity. The predicted increase in global temperature (annual average 1.1–6.4 °C) and the changes in the amount and distribution of precipitation², represent a significant challenge for the plants and habitats within and outside of protected areas³. Alpine plants within and outside protected areas are expected to experience significant impacts as a result of climate change during this century⁴. According to Theurillat et al.⁵, high mountains such as the Alps can be particularly vulnerable to climate change, and the impact of the combined effects of human activity and climate change is more and more visible⁶. The concept of

¹ https://ec.europa.eu/environment/nature/info/pubs/docs/brochures/nat2000_alpine.pdf

² IPCC [Intergovernmental Panel on Climate Change]. (2007). Summary for policy makers. In M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, & C. E. Hanson (Eds.), *Climate change 2007: Impacts, adaptation and vulnerability* (Contribution of working group II to the fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC)). Cambridge: Cambridge University Press.

³ Andrade, P. A., Herrera, F. B., & Cazzola, G. R. (Eds.). (2010). *Building resilience to climate change: Ecosystem-based adaptation and lessons from the field*. Gland: IUCN.

⁴ Erschbamer, B., Kiebachner, T., Mallaun, M., & Unterluggauer, P. (2009). Short-term signals of climate change along an altitudinal gradient in the South Alps. *Plant Ecology*, 202, 79–89.

⁵ Theurillat, J.-P., Felber, F., Geissler, P., Gobat, J.-M., Fierz, M., Fischlin, A., Küpfer, P., Schlüssel, A., Velutti, C., & Zhao, G.-F. (1998). Sensitivity of plant and soils ecosystems of the Alps to climate change. In P. Cebon, U. Dahinden, H. C. Davies, D. Imboden, & C. C. Jaeger (Eds.), *Views from the Alps: Regional perspectives on climate change* (pp. 225–308). Cambridge: MIT Press.

⁶ Fischlin, A., Midgley, G. F., Price, J. T., Leemans, R., Gopal, B., Turley, C., Rounsevell, M. D. A., Dube, O. P., Tarazona, J., & Velichko, A. A. (2007). Ecosystems, their properties, goods, and services. In M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, & C. E. Hanson (Eds.), *Climate change 2007: Impacts, adaptation and vulnerability* (Contribution of working group II to the fourth assessment report of the Intergovernmental Panel on Climate Change, pp. 211–272). Cambridge: Cambridge University Press.

adaptative management of nature reserves can become a possible way to respond to climate change influences proactively⁷.

1.2 Settlements in Alpine region and municipal infrastructure

Settlement in the Alpine world comes in many forms. At the bottom of the river valleys are mainly concentrated agglomerations, while scattered settlements and isolated farms occur throughout the surrounding hilly world. Above all, dispersed settlements are a problem, as settlements are often more challenging to access and still mostly equipped with septic tanks. This places the responsibility for sludge disposal on the individual. However, the awareness of individuals, especially in the rural world, is not yet so high that they know how sludge should be handled.

⁷ Fazey, I., Gamarra, J., Fischer, J., Reed, M., Stringer, L., & Mike, C. (2009). Adaptation strategies for reducing vulnerability to future environmental change. *Frontiers in Ecology and the Environment*, 8(8), 414–422.