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Supporting ecological compensation for mining projects in the arid zones of Central Asia: an approach in terms of ecosystem services

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The arid ecosystems of Central Asia provide many ecosystem services that benefit the local populations and the multi-species pastoral livestock of these territories. In addition, the subsoils of these areas are rich in minerals, hence significant mining activity. Mining projects require an Environmental Impact Assessment, a study which describes the impacts on the environment and recommends measures against them. Among those measures, there is in the following order (i) Avoiding; (ii) Minimizing; (iii) Restoration; (iv) Compensation: it is the “Mitigation Hierarchy”. All these measures aim to achieve the « No Net Loss », or even the « Net Gain » of biodiversity. In Central Asia, the method recommended for the ecological compensation is the monospecific planting of saxauls (*Haloxylon ammodendron* and *Haloxylon persicum*), which are woody xerophyte occurring in the arid zones of Central Asia. Planting is carried out on the same area as the impacted area, or even double it, at high densities. This method raises questions, particularly with regard to the technical success of the plantation, the impact on ecosystems and their services, and the acceptance by local communities. Thus, this thesis aims to support ecological compensation in Central Asia, more precisely in Mongolia, Kazakhstan and Uzbekistan, via an ecosystem approach.

The first objective is to quantify the ecosystem services provided by grazing land in the arid zones of Central Asia. For this purpose, interviews are conducted with local populations and other stakeholders in order to identify the ecosystem services of interest. Subsequently, ethnobotanical surveys and field measurements are carried out in order to study the link between vegetation and ecosystem services. The second objective is the evaluation of different practices that can improve the provision of those services, such as planting or defensive measures. Each identified option is analysed according to its feasibility conditions. Interviews with local populations are conducted to assess the acceptance of these practices. Finally, as a third objective, this thesis aims to propose a tool for the assessment of ecological compensation scenarios, in order to quantify the level of provision of ecosystem services and to assess the economic cost and the level of acceptance for each scenario.

Keywords: Ecological compensation; Ecosystem services; Central Asia

The image is a composite illustrating the morphology and anatomy of *Ficus religiosa*. At the top left, a globe shows the species' distribution in Africa, with an arrow pointing to a map of the continent. The map labels major cities like Algiers, Tunis, and Cairo, and shows the Mediterranean Sea, Red Sea, and Indian Ocean. To the right is a detailed botanical drawing of a tree with handwritten notes in French, including 'Ficus religiosa (L.) Koenig' and 'Ficus religiosa (L.) Koenig'. Below the map are several anatomical drawings: a cross-section of a stem showing vascular bundles, a drawing of a branch with leaves and a terminal panicle, and a drawing of a stem with a large, rounded, terminal panicle. A central text box states: 'Quelques fois l'Égée, les UC sont arrondies : les étages de branches se forment en fil de l'UC'. To the right of this box is another drawing of a branch with a terminal panicle and a drawing of a stem with a large, rounded, terminal panicle. Below these are several photographs of stem sections, labeled 'UC 1' through 'UC 5', showing different growth stages. A central photograph shows a whole tree with a large, rounded, terminal panicle. To the right of this is a photograph of a stem section with a large, rounded, terminal panicle, labeled 'Rameaux horizontaux (libre 4°UC)'. Below this are several photographs of stem sections, labeled 'Arrêts de croissance' and 'Mors de bourgeons terminaux'. At the bottom center is a stylized tree diagram with a large, rounded, terminal panicle.