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Case Report
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A method to rebuild vegetation formations to determinate environmental damage

Abstract

Background: In Chile the environmental damage is regulated by the law No. 19,300, where it is designated that all the negligent or that willfully cause damage to the environment, will be obliged to repair it materially, at their cost, if this possible, and compensate it. Within the environmental damage there is the destruction of native vegetation, only by itself, the cutting of vegetation in Chile does not constitute an act of environmental damage, there must be aggravating circumstances that cause such damage. If the flora component is affected, scientific and systematic reconstruction is needed to be able to evaluate the existence of environmental damage. The present case falls within a process of reconstitution of affected vegetation formations to determine the surface and type of plants intervened and, finally, an assessment of the environmental damage. A field survey was carried out where the "Carta de Ocupación de Tierras" (COT) methodology was applied. This methodology consists of establishing the quantitative aspects of the vegetal architecture, being able to determine the vegetal community. This methodology was applied in the sector adjacent to the intervention area, which is used as a reference environment. Our findings determined that the intervention area is formed by 5 communities corresponding to an intervention of 5.9 ha and 87 species. No species considered to be threatened were identified as being cut, discarding the occurrence of environmental damage.

Keywords: environmental damage, destruction of native vegetation, flora, carta de ocupación de tierras (COT), environmental forensic

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Introduction

The cutting of vegetation has been considered one of the greatest impacts that the human being has made on the ecosystem.[1] The change of the land use (harvesting, deforestation, and conversion of grasslands and wetlands), has been reduced the stock of global terrestrial plant in 45% in the last 200 years, with a third of these being achieved in the twentieth century.[2] The flora and vegetation are a fundamental pillar for the concept of ecosystem service, they purify the air and water, generate oxygen, stabilizes the soil and serves as habitat for the animals.[3] Considering the importance of this ecosystem several countries consider the cutting of vegetation and plants as illegal.[4–7] An example is what happens in Chile, where the cut of native vegetation might be considered as an environmental damage. In Chile the environmental damage is regulated by the law No. 19,300 (General Bases of Environment), where it is designated that all the negligent or that willfully cause damage to the environment, will be obliged to repair it materially, at their cost, if this possible, and compensate it in accordance with the law.[8,9] Environmental damage involves the obvious transgression to the constitutional right to live in an environment without pollution.[8] In this way, the 19,300 law defines environmental damage for all legal purposes as "*any loss, decrease, detriment or significant impairment inferred to the environment or to one or more of its components* (article 2 letter e)". Within the environmental damage there is the destruction of native vegetation.

It is worth mentioning that, only by itself, the cutting of vegetation in Chile does not constitute an act of environmental damage. There must be aggravating circumstances that cause such damage. Establishing the significance of the damage must be related to the environmental components of the intervened area. For example, article 41 of the 19,300 law sets that "*the use and management of renewable natural resources shall be ensuring its regenerative capacity and biological diversity associated with them, in species classified in the article 37*". It is inferred that a significant impairment occurs when there is presence of species listed as threatened within the affected area.[9] Environmental forensic is the systematic and scientific evaluation of physical, chemical and historical information for the purpose of developing defensible scientific and legal conclusions regarding the source or age of a contaminant released into the environment.[10] If the flora component is affected, scientific and systematic reconstruction is needed to be able to evaluate the existence of environmental damage. The present case falls within a process of reconstitution of affected vegetation formations to determine the surface and type of plants intervened and, finally, an assessment of the environmental damage.

Case presentation

The present case is part of the control process carried out by the Superintendence of the environment, a Chilean state agency whose function is to organize and coordinate the monitoring and inspection of the Environmental Qualification Resolutions, as well as the elution of Law 19,300. Product of the faculties of this state agency, this superintendency sanctioned the cutting of vegetation formations in an Andean sector, alluding that this intervention generated environmental damage to the local flora. As it was mentioned, cutting the vegetation in Chile does not constitute an act of environmental damage by itself, there are aggravating factors that cause such damage. Among them, are the presence of species considered as threatened or vegetation that is considered as relictual. So, it was necessary to rebuild the intervened area and to analyze the characteristics of the sector and to carry out a scientific analysis on the possible environmental damage.

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A field survey was carried out where the "Carta de Ocupación de Tierras" (COT) methodology[11] was applied. This methodology consists of establishing the quantitative aspects of the vegetal architecture, its horizontal and vertical distribution on the surface, being able to determine the vegetal community that is defined as a set of plants of one or more species that coexist in a certain area. This methodology was applied in the sector adjacent to the intervention area, which is used as a reference environment. The COT methodology allows to describe the vegetal community through three concepts. First is the plant formation, that corresponds to the set of plant species, belonging or not to the same species, which present convergent characters in both their form and behavior, constituting an eminently physiognomic approach. As a result, it is possible to determine how the community is structurally constituted, if it corresponds to a forest, a scrub or a prairie. The second concept is coverage or covering. This represents the proportion of the terrain that is occupied by vegetation or its vertical projection. This criterion provides information on the abundance of different biological types and is expressed as a global percentage or by strata. The third concept describes the dominant species, that corresponds to those plants whose morphological characteristics mark the community.

During the summer of 2017 we held a field survey to the area were the superintendency sanctioned the cutting of vegetation formations. The area is located in the Andes mountains, in a semiarid environment with a mountainous relief of abrupt nature, giving a xerophilous appearance, dominated by low shrubs and pulvine grasses. First, we determinate the areas were the vegetation was cut, produced by the construction of inner roads. The intervention generated a cut of 5,9 ha of vegetation. Then, reference environments were identified close to the cutting sectors, which serve as a guide to reconstruct the type of vegetation affected. The COT methodology was carry on the reference environments. First, we determinate de formation, then the coverage was established, and at last the dominant species were described. Finally, we determinate the floristic inventory. This corresponds to the list of plants present within the reference environment, which are identified directly in the field. In the case of determining an unknown species, it is photographed and contrasted with the specific literature. We place greater emphasis on finding those species that are considered threatened. Threatened species are classified according to Chilean legislation.

When reference environments are fully described, we extrapolate the data to reconstruct the affected vegetation. Our findings determined that the intervention area is formed by 5 communities corresponding to an intervention of 5.9 ha (Table 1) and a total of 87 species. No species considered to be threatened were identified as being cut. Once the affected vegetation has been reconstituted, it is determined if there was environmental damage. For the evaluation, a methodology based on mathematical calculations was used.[12] That allowed us to quantify and qualify the affectation generated by the works on the flora. Said methodology integrates the magnitude of the Impact, corresponding to the characteristics of the cut and the environmental relevance, which incorporates the environmental conditions of the reconstructed medium. Since there were no species considered as threatened and a low intervention area was found (Table 1), the occurrence of environmental damage is was not determined.

Table 1 Description of vegetal community

Community	Plant formation	Covering	Dominant species	Cut surface (ha)	Number of plant species in the community
Community 1	Prairie	5%	*Mulinum spinosum,* *Berberis empetrifolia* *Nasella sp*	3,1	41
Community 2	Prairie	25–0%	*Mulinum spinosum,* *Chuquiraga oppositifolia,* *Haplopappus anthylloides,* *Nasella sp,* *Senecio microphyllus*	0,6	36
Community 3	Scrub	25–50%	*Colliguaja integerrima,* *Baccharis linearis,* *Schinus montanus*	1,2	39
Community 4	Scrub	25–50%	*Colliguaja integerrima,* *Baccharis linearis,* *Kageneckia angustifolia*	0,6	44
Community 5	Forest	10–25%	*Kageneckia angustifolia*	0,3	54

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Discussion

The present study is based on an alleged environmental damage generated by the cut of local flora, which was initially sanctioned by the Chilean Superintendence of the environment. Considering that the environmental damage in Chile depends on the type of species that were intervened, it was necessary to reconstruct the intervened area, with the objective of determining the real occurrence of the damage. To achieve this goal, the COT methodology was used. As a result, it was determined in the field that in the affected area there were no species considered as threatened, in addition to the fact that the intervention was of low surface area. therefore, no environmental damage occurred. It is considered that for the implementation of this methodology it is not necessary to use electronic devices of high technology, being considered as a low-cost technique. However, it is necessary to be able to find a reference environment, as well as having a high knowledge of the local flora. The COT methodology allows reconstructing, through a reference environment, the vegetation that was cut. Being able to determine the structural form that this one presented as well as the composition of species that this one had. The above is very important since the environmental damage in Chile is based on the threat criteria and, therefore, it is fundamental to establish how the area is constituted.

Is considered that the COT methodology is a scientific procedure, thus is based on the criteria of the Environmental forensic. The Environmental forensic, use science to answer a legal question, in this case the principal part is to identify the victim, the species that were cut. Some species are protected and other are not, this difference can lead to the existence or not of environmental damage. The people that illegally cut vegetation know the different in the law so that, when caught the often claim that the plants that they affected is an unprotected species, so they didn´t commit environmental impact. Unless an investigator proves, the suspect will not pay for the damage made. That is why the methodology presented in this case is of great importance, not only in Chile also worldwide, since it provides a scientific approach to the reconstruction of the flora and vegetation that was cut and be able to determine faithfully if there was environmental damage. The COT methodology can not only be used to determine environmental damage, it can also be used to determine how the vegetation of the sector was formed for future environmental compensation. The illegal cut of vegetation is a global problem, to have methodologies that can rebuild the affected communities is of great importance, since it obliges the culprits to compensate with the same biodiversity that was affected.

Conclusion

In conclusion, it is established that the cot methodology is a technique with which the flora and vegetation of an intervened area can be reconstructed, in a well-founded manner and through a scientific evaluation. Therefore, it is possible to be used to determine the existence of environmental damage.

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Conflict of interests

Authors declare that there is no conflict of interest.

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