Development of a multi-factorial decision making support tool to value carbon storage and key forest functions: implications for the establishment of a PFES (Payment for Forest Ecosystem Services) under climate change.

We present a novel valuation method that can be readily implemented in most countries upon availability of a forest inventory network and spatial environmental and socioeconomic information. The approach is a muti-factorial assessment that allows policy managers to rank priorities among conflicting goals and spatial constraints. In addition values can be monetized and included in a cost benefit analyses to link specific action to a given budget. Moreover the approximation is design as to compile with key international agreements related to climate change, desertification and biological diversity conservation.

Decision making under multiple objectives must consider legal, administrative, social and environmental constraints. The quantification of ecosystem services requires the calculation of real values and prediction, and also considers the weighting factors to promote and objectively recognize the value of conservation and risk prevention.

Our multi-factorial approach quantifies of carbon storage and productivity flows, along with other factors such as biodiversity, fire risk or desertification and takes into account weighting factors provided by the decision maker (expert-based approximation) and stakeholders consensus (normative approximation).

We quantify and value ecosystem core functions as follows: (1) a biophysical approach integrating the fundamental annual ecosystem services (i.e. the quantification of carbon storage and flow or productivity) along with the key factors for determining such services (i.e. climate, soil type, fire history etc) ; (2) an economic approximation using market carbon prices (i.e. due to mitigation policies) ; (3) a weighting approach that includes factors that indirectly influence carbon storage and productivity (ie, risk or conservation factors such as biological diversity, Nature 2000 etc) and finally 4) an expert-based and normative scheme including stakeholders to take payment action based on spatial visualization and cost-benefit analyses of different options.

The computational method is based on big-data approximations, chiefly maximum likelihood estimation and non parametric model fitting. More than 500,000 trees on a one km^2 grid have been re-measured every ten year. We have combined tree allometric information and growth models to estimate carbon sequestration rates. This information has been linked to spatial environmental information managed by the Spanish Ministry of Environment to identity key drivers of forest productivity such as function diversity and to generate predictive biophysical models of forest productivity. For the multi-criteria assessment a layer of a spatially interpolated model output has been integrated with spatial goals and constraints from the Spanish Ministry Strategy (i.e. desertification risk, fire prevention policy or biological diversity preservation). After multi-criteria assessment specific expert based rank values and monetary values are given to each forest stand and region.

We obtained that the Iberian forests are storing and producing carbon with some differences depending on the type of forest and particularly with its Mediterranean, temperate or exotic character. The structure of the forest was a strong determinant of carbon storage and productivity in Iberian forests even more so than functional diversity.

Specific results will be provided for each forest-type. Finally we have projected the model under different climate change scenarios to examine likely changes in the carbon sink as well as in productivity flows including error analyses.

In the meantime multiple ecosystem services and contingent valuation methods are better described and parameterized for each ecosystem this approximation -which has been designed as a collaboration among policy makers and scientists- allows us to take action now and reach payment schemes that compromise stakeholder options and international agreements.

The approach is aligned with Millennium Ecosystem Assessment approach as calculations depart from supporting services. Secondly, it emphasizes climate regulation services as it allows each region, country or international body to establish a common forest mitigation accounting. This way, payments can be standardized according to each country development goals.

The emissions and mitigations of co2 from the countries of the world in a homogogenic way can be checked through an international organization to be able to share a unique and adjusted method to the changing reality of their forest ecosystems produced by the greenhouse effect. Additionally, payments will be adjusted in a standardized way for everyone and a global emissions and mitigation control will be taken to acquire measures according to the reality of the problem, allowing developing countries to collect money for the mitigations of their forest ecosystems services always and when they were greater than the payments they would have to perform through the co2 emissions that would produce their industrial development. It would grow without destroying forest ecosystems or it would grow but more if it is

The methodology is a multifactorial formula system that adds algorithmic calculations to stick to future changes. If the next phase is accepted as a universal model, it would be an application that automates all calculations and measurements in the same way in all countries. In this way we could know the global CO2 balance in real time or simulate models changing certain conditions that will change with the "Climate Change"

In conclusion, the methodology provides policy makers with a multi-factorial equation to estimate supporting and other key services so a comparable standardized accounting of mitigation and other policies can be implemented and monitored.

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