**Title**

Spatial Harmonizing of Protected Areas and Renewable Energy Production

**Authors**

Serrano-León H, Kraxner F, Leduc S

**Affiliations list**

Ecosystems Services and Management Program (ESM), International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

**Abstract**

Climate change mitigation requires transboundary strategies for the expansion of renewable energies (RE) that are compatible with conservation objectives. The diversity of protected areas (PAs) gives room for integration of a sustainable RE development with nature conservation, but the lack of consistency between PAs designations remains a challenge for transboundary planning.

We propose a methodology to harmonize compatibility assumptions between PA and RE potential production. The methodology is based on the International Union for Conservation of Nature's (IUCN) System of Protected Areas in order to be independent from national and regional PA designations. Our approach is based on protection scenarios in order to address the multiple uncertainties regarding compatibility assumptions. Three scenarios were defined as: reduced, medium, and increased protection levels.

The three scenarios assigned different compatibility levels for RE potentials to the different PA classes, varying from no restrictions for RE to total incompatibility. The methodology was tested in the Alpine region for four different RE technologies: bioenergy, wind power, solar PV plants, and hydropower. A spatial analysis was carried out using GIS and the sustainable as well as the economic potential for each RE technology were determined using a techno-economic engineering model for RE systems (BeWhere) developed at IIASA.

The results showed considerable trade-offs between nature protection and the potential for RE production, with significant differences depending on the scenario assumptions. Available area and potential for RE production was notably reduced when higher restrictions were assumed (lower compatibility levels, additional buffer with restrictions to protect the strictest PAs, and exclusion of Natura 2000 sites). This study evidences the importance of clear definition of PA management objectives for strategic planning of sustainable RE expansion.

# Harmonizing compatibility assumptions between protection designations and renewable energy potential

Hernán Serrano León*, Sylvain Leduc, Florian Kraxner

Ecosystems Services and Management Program (ESM), International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

## Background

- Climate change mitigation requires transboundary strategies for the expansion of renewable energies (RE) that are compatible with nature conservation objectives.
- However, there are multiple associated uncertainties:
  - lack of consistency between protected areas (PAs) designations
  - different local potential impacts of RE projects and different compliance levels of stakeholders
- **We propose a methodology to harmonization of protection constraints assumptions for strategic planning of RE production.**

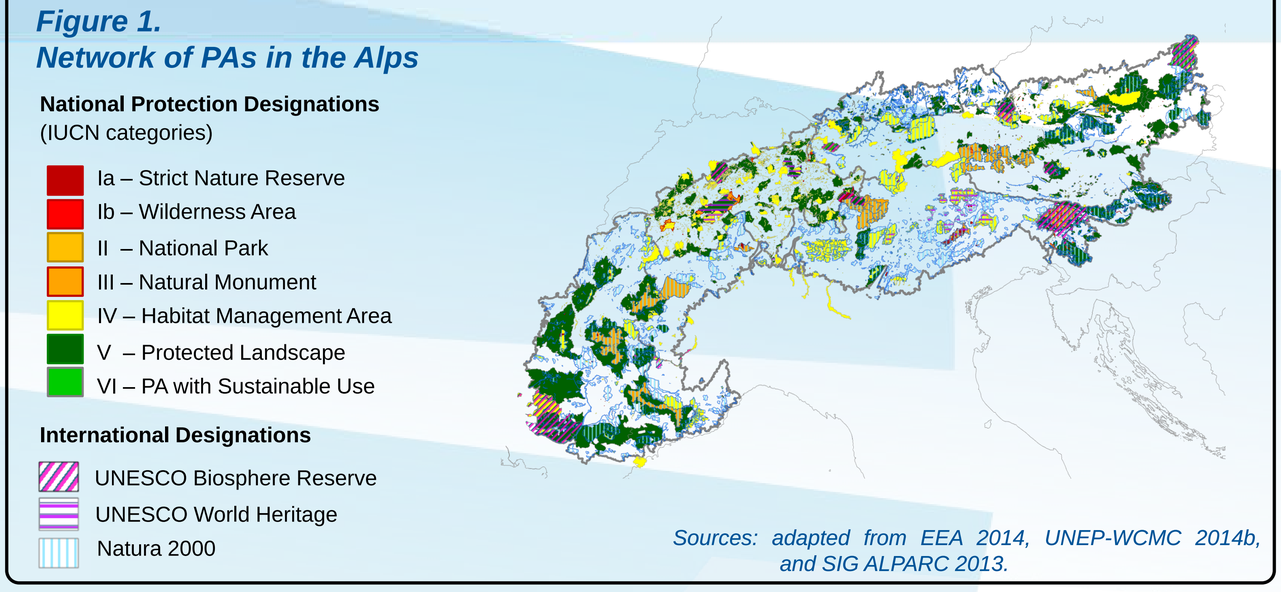
## Methodology

- used the International Union for Conservation of Nature's (IUCN) System of Protected Areas (Dudley 2008).
- 3 scenarios with different compatibility levels for RE potentials assigned to the different PA classes and scenarios (Table 1).
- tested in the Alpine region for four different RE technologies: bioenergy, wind power, solar PV plants, and hydropower.
- spatial analysis using Geographic Information Systems (GIS).
- sustainable and economic potential for each RE technology determined by BeWhere (a techno-economic engineering model for RE systems).

## Results

- considerable trade-offs between nature protection and the potential for RE production.
- available area and potential for RE production notably reduced by:
  - lower compatibility levels,
  - additional buffer restrictions to strictest PAs,
  - exclusion of Natura 2000 sites.

***Figure 1.***
***Network of PAs in the Alps***




*Sources: adapted from EEA 2014, UNEP-WCMC 2014b, and SIG ALPARC 2013.*

| | % of potential RE production considered compatible | | |
|---|---|---|---|
| | **Reduced protection** (Scenario 1) | **Medium protection** (Scenario 2) | **Increased protection** (Scenario 3) |
| **IUCN Cat. I** | 0 | 0 | 0<br>+ 5 km buffer: 20 |
| **IUCN Cat. II** | Core area: 0<br>- 2,5 km zoning: 20 | 0 | 0<br>+ 5 km buffer: 20 |
| **IUCN Cat. III** | 0 | 0 | 0<br>+ 2.5 km buffer: 20 |
| **IUCN Cat. IV** | Core area: 0<br>- 2,5 km zoning: 20 | 0 | 0 |
| **IUCN Cat. V** | 90 | 50 | 20 |
| **IUCN Cat. VI** | 50 | 30 | 10 |
| **Natura 2000** | - | 50 | 0 |
| **UNESCO World Heritage *** | - | Core area *: 0<br>- development area: 50 | Core area *: 0<br>- development area: 20 |
| **UNESCO Biosphere Reserve *** | - | Core area *: 0<br>- development area: 50 | Core area *: 0<br>- development area: 20 |

** Core area in UNESCO sites given by the overlaying stricter PAs.*

***Table 1.***
***Proportion of potential RE production considered compatible with the management objectives and zoning of each protected area and scenario.***

**Scenario 1 – Reduced protection level** | **Scenario 2 – Medium protection level** | **Scenario 3 – Increased protection level**

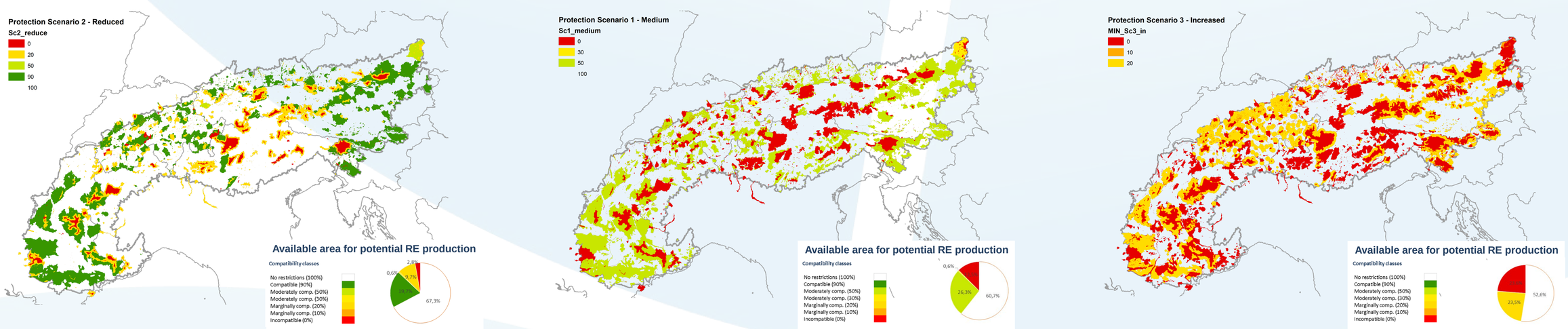
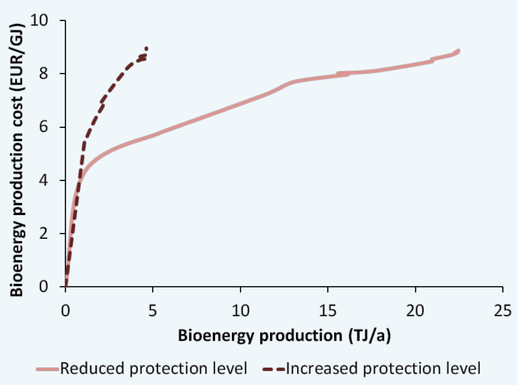



***Figure 2. Protection constraints spatial analysis for the potential RE production considering reduced (left), medium (middle) and increased protection levels (right).***

## BeWhere results




Example of results from the BeWhere model on the production cost and bioenergy potential for two environmental protection levels.

## Conclusions

- Realistic approach to evaluate protection constraints on RE potential calculations.
- Different protection scenarios address the multiple uncertainties regarding compatibility assumptions.
- Methodology independent from national and regional PA designations.
- Coherent basis for improving strategic RE planning across national boundaries.

*** Contact**

**Hernán Serrano León**, Research Assistant

E-Mail: hernanserranoleon@hotmail.com
Skype: hernan.s.l

**More information**

www.recharge-green.eu
www.iiasa.ac.at/bewhere
www.iiasa.ac.at/ESM

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