Developing a framework for assessing the impact of geothermal development phases on ecosystem services

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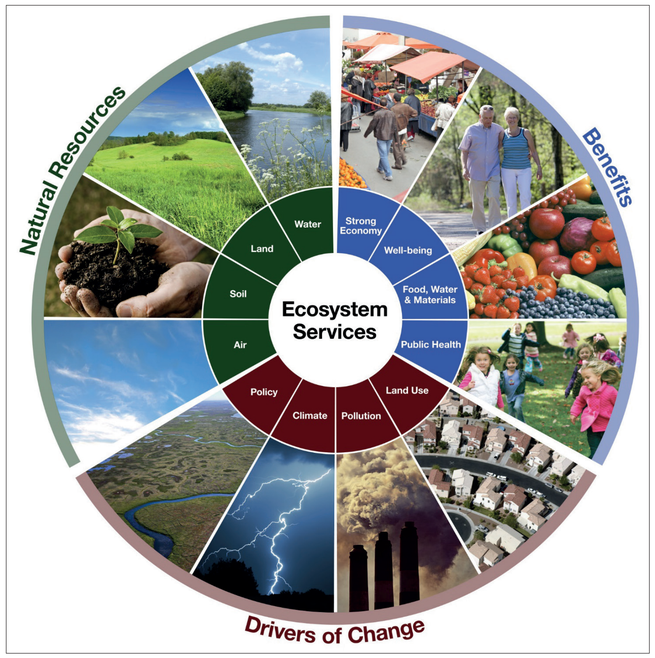
BACKGROUND

- Indonesia's total potential geothermal resources and reserves are estimated at 28.994 Mwe
- The Indonesian National Energy Policy target is to reach energy usage of 7.000 kWh in the year 2050
- The development of geothermal energy infrastructure affects the surrounding ecosystem services
- The length of the effect varies: temporarily (during construction or demolition), during power plants operation (e.g. noise nuisance), or permanent
- People value the environment differently, current decision making does not always takes local values into account, making geothermal development not optimal
- The ecosystem services concept can be used as an approach to address social and ecological impact and development (Ranganathan, J. et al. 2008)

RESEARCH GAPS

- What is the spatial impact of each geothermal development phase on ecosystem services?
- What approaches that can accommodate the involvement of stakeholders in governing the ecosystem services?

ECOSYSTEM SERVICES APPROACH



(image source: https://www.epa.gov/enviroatlas/ecosystem-services-enviroatlas)

"Ecosystem Services are the benefits humans derive from ecosystem" (MEA, 2005)

Ecosystem service approaches allow for engaging stakeholders in transparent planning and decision making

The ecosystem service framing makes explicit the value of the environment for decision makers

SPATIAL ASSESSMENT OF GEOTHERMAL DEVELOPMENT IMPACT

Table 1. Potential environmental impact of geothermal development phase activity

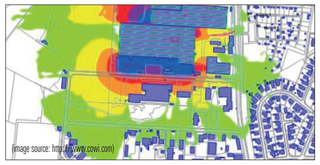
Potential Impact	Geothermal Development Phase			
	Resource Exploration and Drilling	Construction	Operations and Maintenance	Decommissioning and Site Reclamation
Acoustics/Noise (Bayer et al. 2013; DiPippo 2012; TEEIC)	Impacted	Impacted	Impacted	Impacted
Air Quality (Bayer et al. 2013; TEEIC)	Impacted	Impacted	Impacted	Impacted
Cultural Resources (Bayer et al. 2013; TEEIC)	Impacted	Impacted	Impacted	No Impact
Ecological Resources (Bayer et al. 2013; DiPippo 2012; TEEIC)	Impacted	Impacted	Impacted	No Impact
Environmental Justice (Bayer et al. 2013; TEEIC)	No Impact	Impacted	Impacted	Impacted
Hazardous Materials and Waste Management (Bayer et al. 2013; DiPippo 2012; TEEIC)	Impacted	Impacted	Impacted	Impacted
Health and Safety (DiPippo 2012; TEEIC)	Impacted	Impacted	Impacted	Impacted
Land Use (Bayer et al. 2013; TEEIC)	Impacted	Impacted	Impacted	Impacted
Paleontological Resources (TEEIC)	Impacted	Impacted	Impacted	Impacted
Socioeconomics (Bayer et al. 2013; TEEIC)	Impacted	Impacted	Impacted	Impacted
Soils and Geologic Resources (DiPippo 2012; TEEIC)	Impacted	Impacted	No Impact	Impacted
Transportation (TEEIC)	No Impact	Impacted	No Impact	Impacted
Visual Resources (Bayer et al. 2013; DiPippo 2012; TEEIC)	No Impact	Impacted	Impacted	No Impact
Water Resources (Surface Water and Groundwater) (Bayer et al. 2013; DiPippo 2012; TEEIC)	Impacted	Impacted	Impacted	Impacted
Geological Hazards (Bayer et al. 2013; DiPippo 2012)	Impacted	Impacted	Impacted	No Impact

Impacted No Impact

People receiving benefits from ecosystem in geothermal area

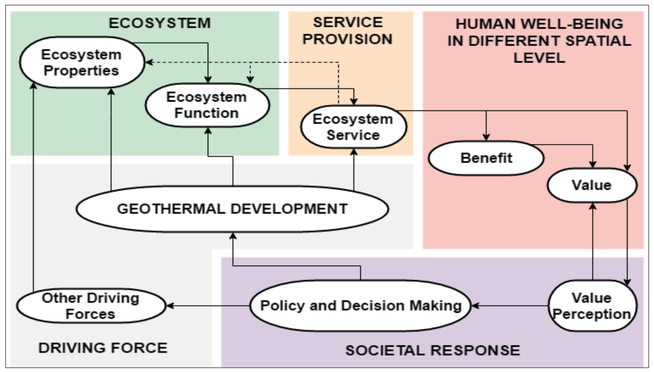
Drilling rig at Sarulla project, Indonesia

Geothermal power plant inside Mount Halimun-Salak National Park



Colored noise contour maps give an overall indication as to where noise problems can be expected.

PROPOSED ASSESSMENT FRAMEWORK



Proposed framework for assessing links between geothermal development, ecosystem services provision, and human well-being (modified from van Oudenhoven et al. 2012). Solid arrows indicate effects; dashed arrows indicate feedbacks

FUTURE WORKS

- Selecting ecosystem services indicators, and developing scenarios per geothermal development phase.
- Study the spatial and temporal variations in biophysical and socio-economic ecosystem service values in relation to geothermal field development scenarios.

Acknowledgement

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Geothermal Capacity Building Program Indonesia - Netherlands