PLANINNG AND ENGAGEMENT ARENAS FOR RENEWABLE ENERGY LANDSCAPES

PEARLS

Marie Skłodowska -Curie Actions (MSCA)

Research and Innovation Staff Exchange (RISE)

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Dissemination level	Public

Version 1 change record

Version	Date	Status	Author (Unit)	Description
0.1	2022-09-26	Draft	USE; BGU; AUTH; GSH	First Draft from Spain
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0.3	2022-10-27	Draft	USE	Fieldwork
0.4	2022-11-2	Draft	USE	First Complete Draft
0.5	2022-11-4	Final Version	USE	Final Draft

Abstract:

Deliverable 2.3 entitled Research Seminar corresponds to WP 2 SUSTAINABLE IMPLEMENTATION: POLICIES AND PRACTICES led by the University of Seville and Ben-Gurion. This Deliverable collects the content of this activity that has been carried out in the Faculty of Geography and History of the University of Seville on 25 and 26 October 2022. These has been enabling dissemination of the PEARL*S* project's objective, findings, and deliverables to wider audiences by the host institution. To reach this, the Research Seminar has been incorporated into the Doctoral Program in Geography of the International Doctoral School of the University of Seville.

The Deliverable collects the content of the presentations made by the three lecturers during the first day of the seminar as well as the field trip made on the second day to the thermos-solar plants Valle 1 and Valle 2 in the municipality of San José del Valle, in Cádiz. To strengthen the relationships between the participants, a networking event was also organized for those attending the seminar who are part of the PEARL*S* project.

Index:

I. Introduction

This deliverable contains the fourth task to WP 2 SUSTAINABLE IMPLEMENTATION: POLICIES AND PRACTICES. The WP objectives were formulated in i) the framework to examine and compare national energy policy, land use planning and landscape practice schemes; ii) to analyze environmental impact assessment procedures to enable the inclusion of natural and cultural aspects to construct a return mechanism for policy makers; and iii) to research and develop tools to increase public participation in energy policy and renewable energy landscape implementation practices. To put the three of them in value, WP2 includes research and training together with support for dissemination by WP1. The idea is to facilitate and disseminate a better understanding of legal frameworks and daily practice in the implementation of REL within PhD students.

The WP tasks comprise Research Reports (D.2.1.) from participating countries following a common scheme. These reports have been establishing by the national contexts frameworks for the construction of comparative energy policy, land use planning and landscape practice. The second task consists of deep interviews with national/regional policy makers and technicians to obtain direct information about the public participation system in renewable energies implementation. The final task will consist of three types of outputs: a) to analyse environmental impact assessment procedures to enable the inclusion of natural and cultural aspects; b) to construct a return mechanism for policy makers; and c) fieldwork on real EIA specific cases. All these outputs allow WP2 participants to prepare two co-authored papers on energy policy and REL spatial planning and b) to organise a Research Seminar for PhD Students.

The Research Seminar has been held by the University of Seville together with Ben Gurion University last 26 and 27 October 2022. The Seminar has consisted in two daily sessions of lectures and fieldwork. A networking event has been held in between to reinforce PEARLS project capacity to facilitate knowledge sharing trough secondments experiences. Due to the international approach of this activity, the Seminar has been co-founded to the Doctoral Programme in Geography from the University of Seville. The total amount of participants has been 37 people within PhD students (12), PEARL*S* secondments and local participants (25).

II. Research Seminar organization and contents

This Research Seminar has been organised by the University of Seville. The objective pursued has been both to fulfil the WP2 task agenda resulting from the research carried out throughout the project and to prepare this deliverable. To achieve this, it was essential to have the participation of those members of the project who were able to offer relevant results while opening their dissemination to a wider public. The initial idea of organising an activity for PhD students participating in PEARL*S* as secondments gave way to other secondments from the non-academic sector as well as to PhD students from the University of Seville who are not involved in the PEARLS project to date. This proposal fits perfectly into the Geography PhD Programme of the University of Seville. Hence the proposal to organise this Research Seminar as part of this programme.

The Doctoral Programme in Geography of the University of Seville is part of the R&D&I framework of the scientific-professional sector of Geography through several research teams recognised for their national and international prestige. Some members of these teams bring to the programme outstanding management experience in the public administration and the business world, in areas as relevant as planning, land management, regional development and R&D&I. The lecturers who make up the Programme have been developing various competitive projects and contracts with a high level of initiative and scientific capacity in their commitment to R&D&I, which is the essence of its operation. Particularly noteworthy is the diversity of national and international centres/universities with which collaboration agreements, contracts, or incentive agreements (public and private) have been signed at regional, national, and international level. In addition, its involvement in the Strategic Plan of the University of Seville incorporates an important stimulus to research and innovative experiences in its international projection and in the production and transfer of knowledge.

Due to the importance given to internationalisation, the Research Seminar for PhD students on "Renewable Energy Landscapes and Spatial Planning: A Transnational Mediterranean" was submitted to the call for training activities of the International Doctoral School of the University of Seville. The activity was approved, which has allowed its academic insertion in the PhD Programme in Geography, widening the number of potential participants, and achieving co-funding of the expenses. Therefore, the activity has been offered to students of the Doctoral Programme in Geography from Albania, Chile, Ecuador, Iran, Morocco, and Spain. In addition, PhD students of the PEARLS project from Israel, Italy, and Portugal, as well as Spain, and secondments have attended. To achieve this, the seminar has been online for those who were outside Europe.

To reinforce the visibility of the PEARL*S* Project the Seminar has been renamed Planning and Engagement Arenas for Renewable Energy Landscapes. The contents of the Seminar correspond to the research results of the project and reinforce the regional component through the presentation of a case study.

The structure of the Seminar comprises

1. Three theoretical sessions given by the members of the project.

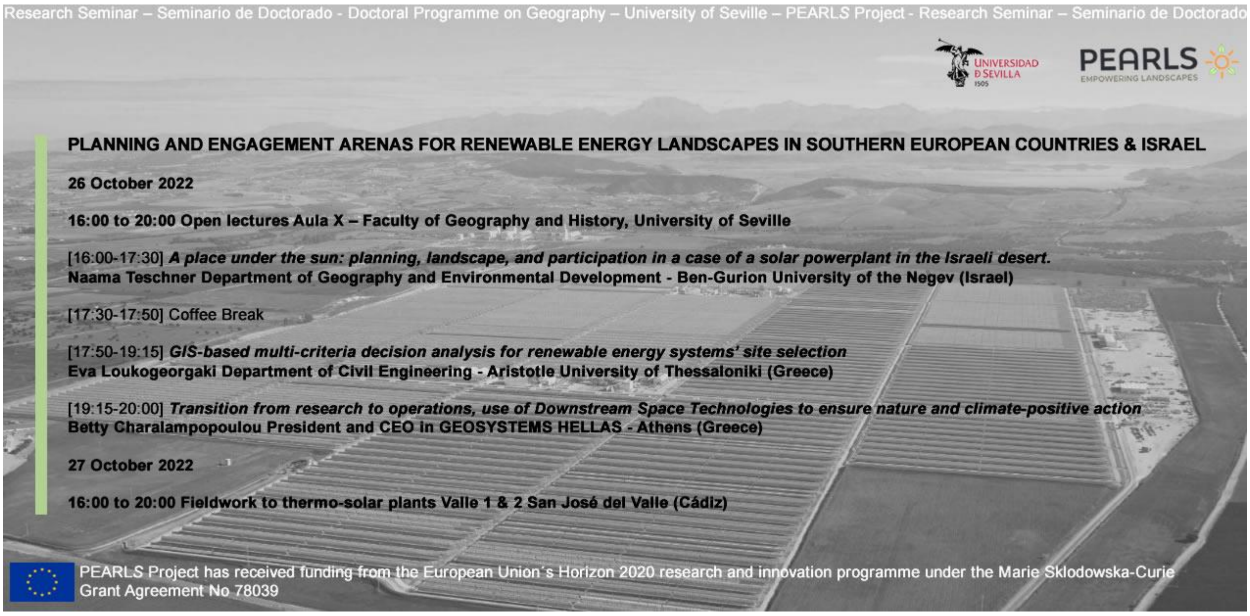
Speaker: Na'ama Teschner. Assistant Professor at the Department of Geography and Environmental Development of the Ben Gurion University in Israel and the head of external relations committee at the School of Sustainability and Climate Change (SSCC)

Speaker: Eva Loukogeorgaki. Associate Professor of Marine Structures in the Civil Engineering Department of Aristotle University of Thessaloniki (AUTh)

Speaker: Vasiliki (Betty) Charalampopoulou. President & CEO of GEOSYSTEMS HELLAS S.A.

2. A field trip to the solar thermal power plants Valle 1 and Valle 2 in San José del Valle, Cádiz, 120 km southeast of Seville https://www.energy.sener/project/valle-1-and-valle-2-plant

Speaker: Mr. Ignacio Grimaldi from SENER Group https://www.group.sener/

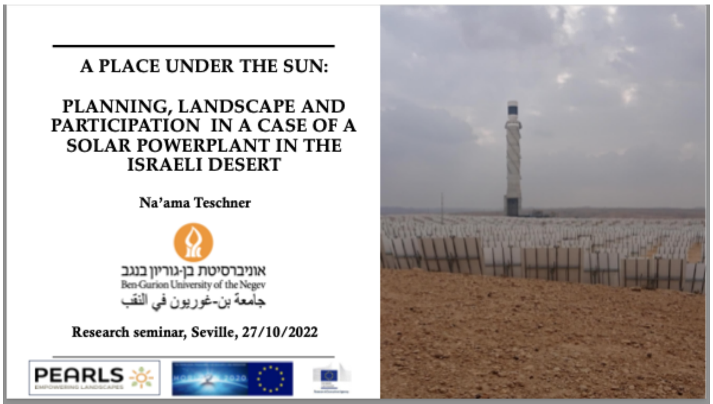


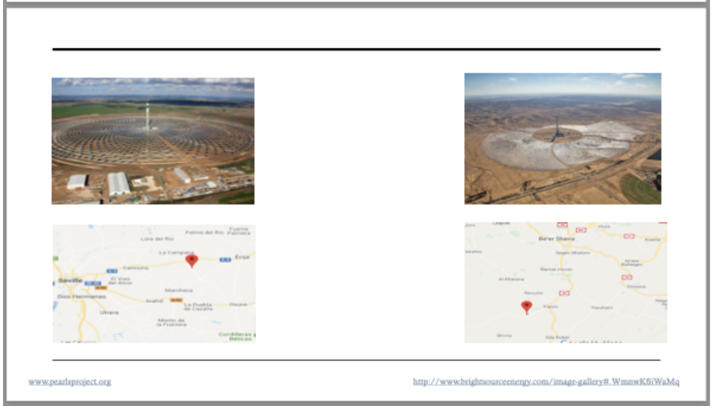
A networking event has taken place between the two activities. The aim was to find a common meeting place in which to strengthen the cohesion of the PEARL*S* project participants who took part in the Seminar. In this way, information on the day-to-day running of the project was shared by participants from the academic and non-academic sectors and to encourage the incorporation of new secondments as part of the exchange of knowledge, work schemes and training experiences.

III. Research Seminar lectures

A place under the sun: Planning, landscape, and participation in a case of a solar powerplant in the Israeli desert, by Na'ama Teschner

This research shows how perceived landscape impacts influence public willingness to accept changes in the landscape. The connection between the effectiveness of LA procedures vis-à-vis the inclusion of the public in decision-making related to RES siting has received less attention. Speaker examines the role of LAs in planning via the eyes of policymakers and experts and evaluate the capacity of current tools to influence the process. Additionally, the role (or lack thereof) of the public in Las is presented. Our unique case—one of the largest in the world thermo-solar "tower" plant, located near a small desert village—exemplifies the place for landscape consideration in national-level mega-infrastructure. Based on documents analysis and semi-structured interviews, the findings demonstrate the struggle between competing goals such as financial and temporal efficiency, RES targets, landscape protection, and public participation. Despite independent efforts to promote the latter two, there may be little connection between the assessment of landscape effects and public participation because there is no mechanism for post-evaluation of a project's impacts, and any debates on the actual effects remain theoretical. Second, that landscape impacts of large-scape infrastructure can mainly be avoided in the stage of site location, and at this stage, the room for public input remains limited.





RESEARCH QUESTIONS

1. What is the role of LA in planning processes of RES?

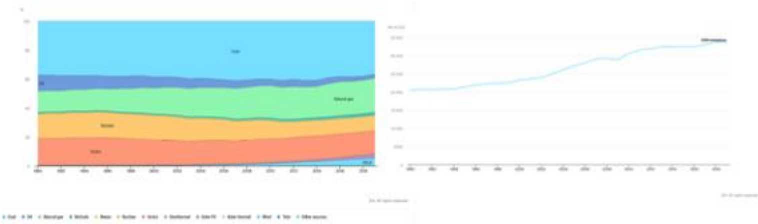
   // To what extant do current tools (EIA, LIA) can influence siting and design processes for RES projects?

1. How do planners and decision-makers perceive the role (or lack thereof) of residents and the general public in LAs, during the plan's appraisal and approval stages?

OUTLINE

- **Introduction**:
  - Climate change and renewable energies: global
  - Solar energy: impacts and trade-offs
  - Social acceptance and public participation
- **Landscape Impact Assessment: definitions, tools, limitations**
- **Case-study**:
  - Background: Israel's energy geographies
  - Planning, landscape and participation in *Ashalim* thermo-solar project
- **Conclusions**

INTRODUCTION:
CLIMATE CHANGE AND RENEWABLE ENERGIES: GLOBAL



Electricity generation by source, World 1990-2019 Source: IEA

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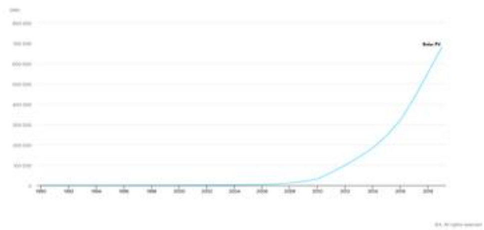
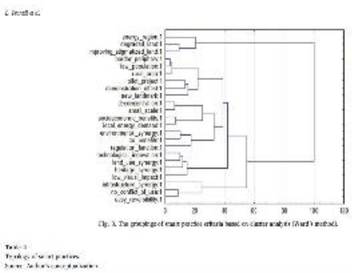
CLIMATE CHANGE AND RENEWABLE ENERGIES: GLOBAL



Solar PV electricity generation, World 1990-2019 Source: IEA

INTRODUCTION:
SOLAR ENERGY: IMPACTS AND TRADE-OFFS



INTRODUCTION:
SOCIAL ACCEPTANCE AND PUBLIC PARTICIPATION

- Social acceptance of RE projects is crucial for transition.
- Yet, visual impact → public rejection of RE plans

[land-use changes, perceptions of risk, general NIMBI?]

- Public support → high level awareness to CC, smaller scales of the projects, financial compensation.

- Conceptual and practical history, and also critiques of PP
- Different levels of PP in planning, also as part of SEA or EIA
- One-way information sharing → legitimatization

→ who is consulted and at which stage of the planning process?

https://carbon.coop/-ot-tisiv-ruo/2016/09/pooc-ygrene-naigleb-tnaillirb-eht-rewopoce

Arnstein's famous participation ladder

LANDSCAPE IMPACT ASSESSMENT (LCA):
DEFINITIONS, TOOLS, LIMITATIONS

- **What is landscape?**
  - Diverse meanings in many disciplines
  - Nature-human divide
  - (70s) "landscape ecology" = geomorphological traits + anthropogenic land-uses. Cultural landscapes (UNESCO)
  - (2000) *"a zone or area as perceived by local people or visitors, whose visual features and character are the result of the action of natural and/or cultural (that is, human) factors"* (European Landscape Convention - ELC)

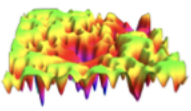
LANDSCAPE IMPACT ASSESSMENT (LA):
DEFINITIONS, TOOLS, LIMITATIONS

- **Procedures of LCAs and limitations**
  - *"the process of identifying and describing variation in the character of the landscape. It seeks to identify and explain the unique combination of elements and features (characteristics) that make landscapes distinctive"* (LCA, UK)
  - Assess the identity of landscapes considering the specific perceptions and values of the people who experience it
  - A wide range of methods and tools for identifying and analyzing landscape impacts of proposed development projects: EIA, SEA, VIA
  - Assessing aesthetic (sense/judgment of impact) and perceptual (e.g., visibility)
  - Lack of consistency in LA approaches and techniques, and the shortage of data: what exactly do you assess and how

→ **The stage** during the planning process when the landscape assessment is conducted and **who is consulted**

LANDSCAPE IMPACT ASSESSMENT (LA):
DEFINITIONS, TOOLS, LIMITATIONS

- **Energy landscapes**

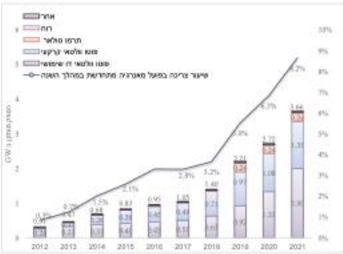


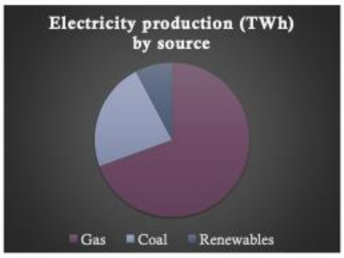
- How society should be dealing with transformations of valued landscapes in the face of the climate crisis?
- Visual impact is a major impediment to obtaining public consent for RES plans (Scognamiglio, 2016; Wolsink, 2019).
- Early stages!! Public participation in landscape appraisal and site-selection is considered crucial (Aitken et al., 2016)
- LAs of RES projects: quantify the visual effects of **shape**, **color**, **visibility** and **size** of the facilities in order to define "suitable" constellations of the technology in particular landscapes
- New cultural features? (Selman, 2010)

METHODOLOGY

- Case-study approach (Israel → *Ashalim* project)
- Extensive documents analysis (planning committees' protocols, policy documents, EIA's official reports, regulation)
- In-depth semi-structured interviews with 11 stakeholders (conducted via phone or zoom): the Ministry of Environmental Protection, the Natural Parks Authority. The Southern District Planning Committee, the regional council, and the Society for Protection of Nature (eNGO)
- Sorting of written materials via coding and thematic analysis

CASE STUDY:
BACKGROUND: ISRAEL'S ENERGY GEOGRAPHIES





Share of RE (installed capacity, MW). Source: Electricity Authority, Annual report 2021)


The New York Times
Egypt and Israel sign 15-year natural gas deal

Bloomberg
Markets
Israel to Boost Gas Supply Up To 50% This Month
- Additional 2-2.5 bcm per year will flow via Ar
- Chevron operates Israel's 2 biggest offshore

By Mirette Magdy
February 15, 2022 at 2:06 PM GMT+2

Lebanon
Israel and Lebanon reach 'historic' maritime border and gas fields deal

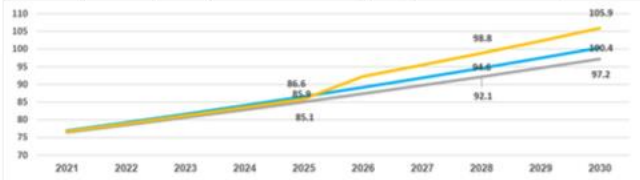
CASE STUDY:
BACKGROUND: ISRAEL'S ENERGY GEOGRAPHIES

- Energy island?
- Population: 9.5 million
- Land: 21,937 km2
- Total RES targets 9.8GW (20&) in 2025 and 30% in 2030
- Most available land in the southern regions, but:
  - Population is in center and north
  - Terrain is problematic
  - No grid
  - And…(next slide)

Suitability analysis of land areas for PV facilities. Source: Shriki et al., 2022

CASE STUDY:
BACKGROUND: ISRAEL'S ENERGY GEOGRAPHIES

- Population growth rate (highest in OECD)
- Electricity demand growth (scenarios of 2.5-3.7% yearly) – exceeds installed capacities



Source: The Research and Information Center, Israeli Parliment, 2021

TECHNICAL DETAILS

- The largest facility in the country (121MW)
- Concentrating thermal Solar Power (CSP) technology 50,600 computer-controlled heliostats covering an area of 3km2 and 240-m-high tower
- Beginning of planning process: 2002
- Facility became operational: 2019
- BOT, national-level planning
- One out of 3 solar fields around *Ashalim*
- Military zone redesignated
- Main EIAs conducted in 2011, 2012

RESEARCH QUESTIONS

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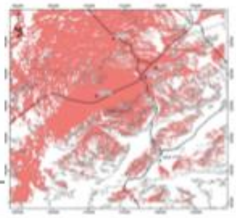
CASE STUDY:
RESULTS

1. Landscape related loopholes in *Ashalim* planning process



- LA is not a legally binding instrument, but commonly integrated
- This initial choice of site (in 2002) is the most crucial one – no LA, no SEA/EIA
- The EIA and LA for site approval were conducted on a theoretical plan, without knowing the technology of the "tower" (270 m high!)
- No authority is setting standards or overseeing LA procedures
- Landscape considerations "falls between the chairs", considered less of importance compared with ecological damage (streams, wildlife)

CASE STUDY:
RESULTS

2. Whose this landscape anyway? Public participation in the project

Ministry of energy, public consultation website, 2016

- No legal requirement for public participation in EIA procedures, only notification
- The public can file objections, voluntary meetings, organized by the developers
- Support from the Regional Council, potential of new energy turism

  The village was compensated with public amenities and only one resident submitted an objection
- Local residents cared more in the planning of electrical substations and high voltage powerlines. This "old" energy landscape involved some negotiation with the local residents who demanded that the stations be positioned as far as possible from the village.

SOME HIGHLIGHTS/CONC.

- *"the more important the facility is to the state, the less influence the EIA has…" (regional council representative)*
- If **LA is so subjective** who should be involved in the assessment of impacts?
- Case-by-case vs. spatial policy
- **Length of planning**: the tools for impacts mitigation are not effective and RE goals are missed
- Scenic impacts: in **site selection stage**!!
- Landscape has little to say in the case of solar energy
- **LA remains a limited tool**: no post-evaluation of actual impacts

THANK YOU

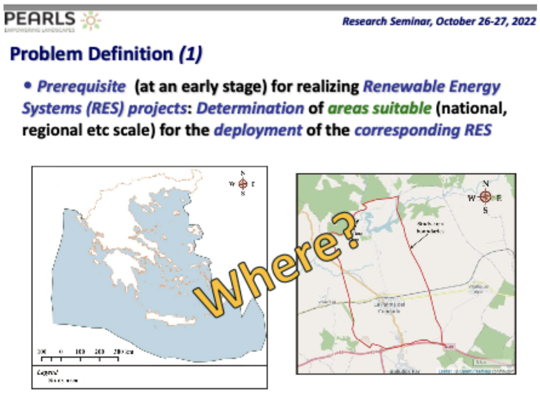
Na'ama Teschner

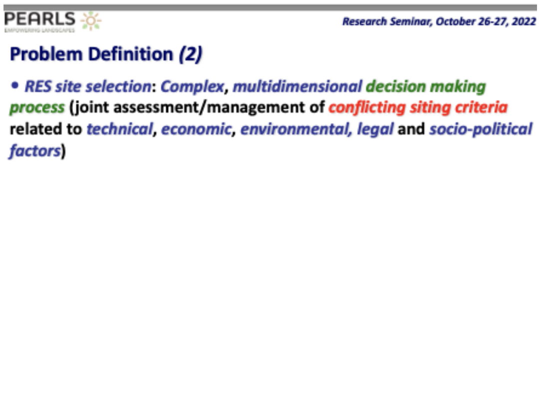
naamate@bgu.ac.il

GIS-based multi-Criteria decision analysis for Renewable Energy Systems' site selection, by Eva Loukogeorgaki

An innovative sustainable spatial energy planning framework is developed on national scale for identifying and prioritizing appropriate, technically, and economically feasible, environmentally sustainable as well as socially acceptable sites for the siting of large-scale onshore Wind Farms (WFs) and Photovoltaic Farms (PVFs) in Israel. The proposed holistic framework of this conference consists of distinctive steps allocated in two successive modules (the Planning and the Field Investigation module), and it covers all relevant dimensions of a sustainable siting analysis (economic, social, and environmental). It advances a collaborative and participatory planning approach by combining spatial planning tools (Geographic Information Systems (GIS)) and multi-criteria decision-making methods (e.g., Analytical Hierarchy Process (AHP)) with versatile participatory planning techniques to consider the opinion of three different participatory groups (public, experts, and renewable energy planners) within the site-selection processes. Moreover, it facilitates verification of GIS results by conducting appropriate field observations. Sites of high suitability, accepted by all participatory groups and field verified, form the outcome of the proposed framework. The results illustrate the existence of high suitable sites for large-scale WFs' and PVFs' siting and, thus, the potential deployment of such projects towards the fulfillment of the further Israeli energy targets.


PEARLS
EMPOWERING LANDSCAPES
H2020 – MSCA – RISE – 2017 – 778039
Planning & Engagement Arenas for Renewable Energy LandscapeS
Research Seminar, University of Seville, Seville, Spain, October 26-27, 2022
GIS – based Multi – Criteria Decision Analysis for Renewable Energy Systems' Site Selection
Eva Loukogeorgaki
Associate Professor of Marine Structures
Department of Civil Engineering, AUTh, Thessaloniki, Greece
e-mail: eloukog@civil.auth.gr
AUTh
WP4 Leader


PEARLS
Research Seminar, October 26-27, 2022
Problem Definition (1)
• Prerequisite (at an early stage) for realizing Renewable Energy Systems (RES) projects: Determination of areas suitable (national, regional etc scale) for the deployment of the corresponding RES
Where?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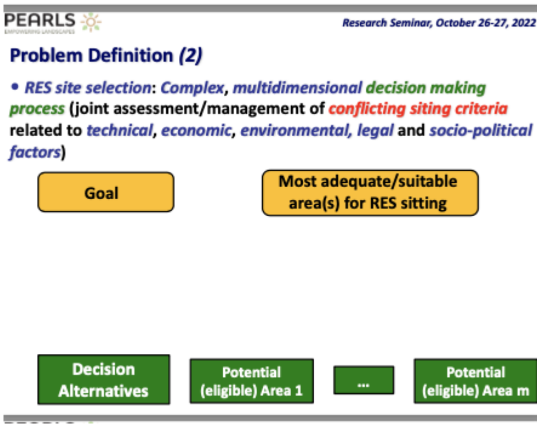
Problem Definition (2)
• RES site selection: Complex, multidimensional decision making process (joint assessment/management of conflicting siting criteria related to technical, economic, environmental, legal and socio-political factors)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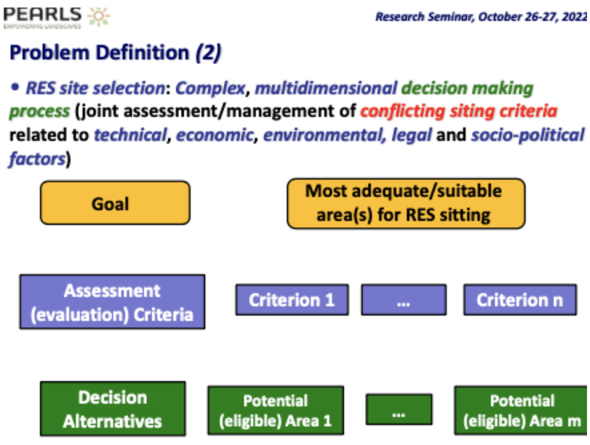
Goal
Most adequate/suitable area(s) for RES sitting
Decision Alternatives
Potential (eligible) Area 1
...
Potential (eligible) Area m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Most adequate/suitable area(s) for RES sitting
Assessment (evaluation) Criteria
Criterion 1
...
Criterion n
Decision Alternatives
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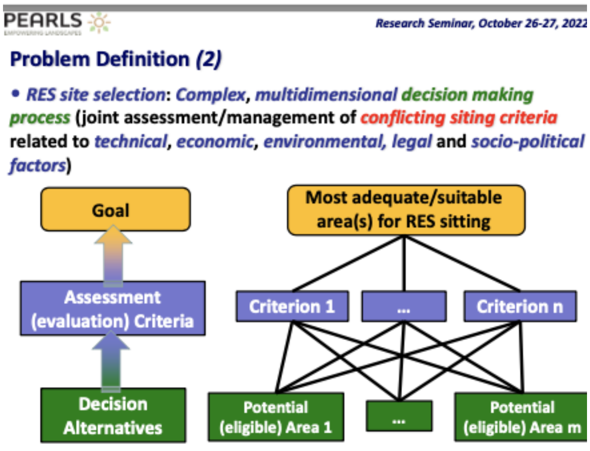
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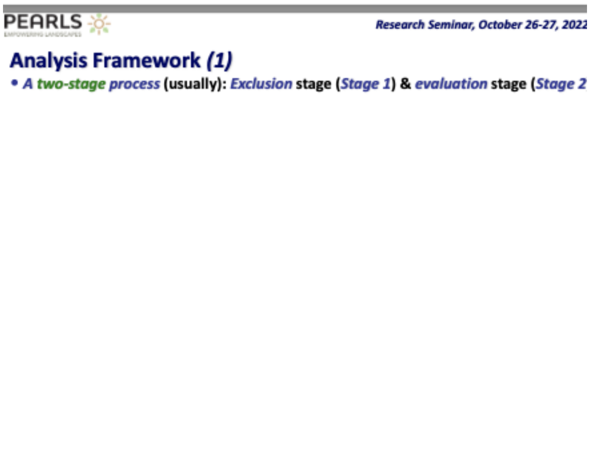
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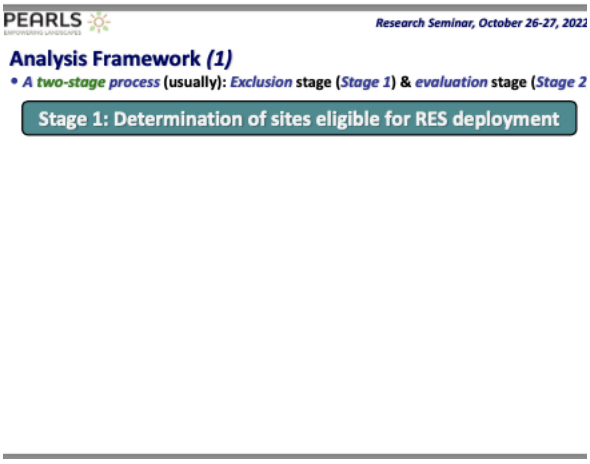
Analysis Framework (1)
• A two-stage process (usually): Exclusion stage (Stage 1) & evaluation stage (Stage 2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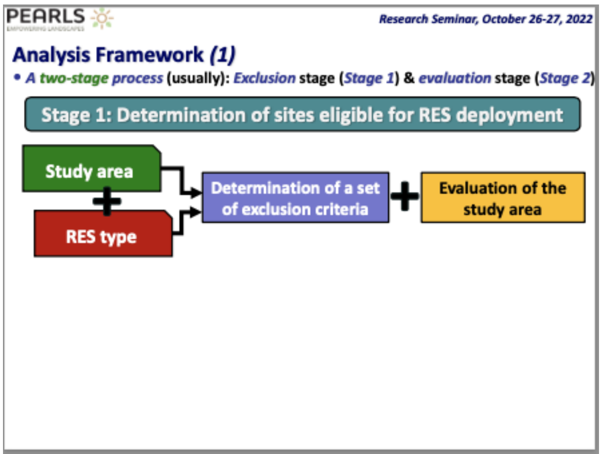
Stage 1: Determination of sites eligible for RES deployment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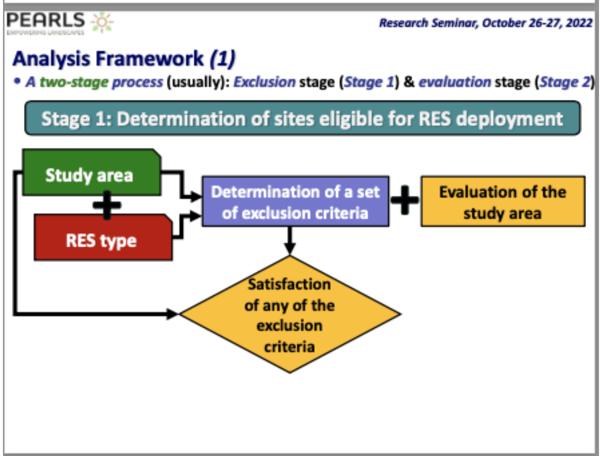
• A two-stage process (usually): Exclusion stage (Stage 1) & evaluation stage (Stage 2)
Stage 1: Determination of sites eligible for RES deployment
Study area
RES type
Determination of a set of exclusion criteria
Evaluation of the study area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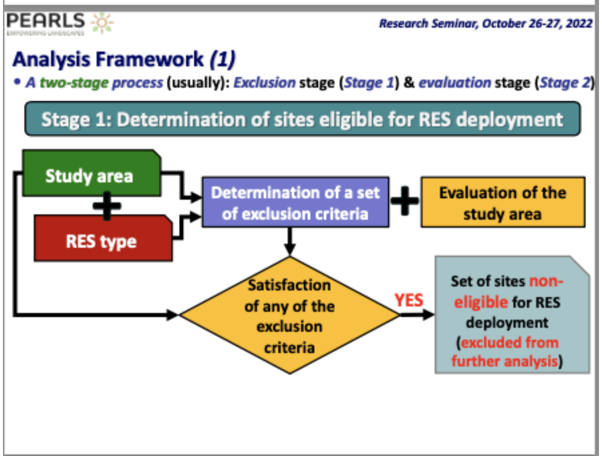
RES type
Determination of a set of exclusion criteria
Evaluation of the study area
Satisfaction of any of the exclusion criteria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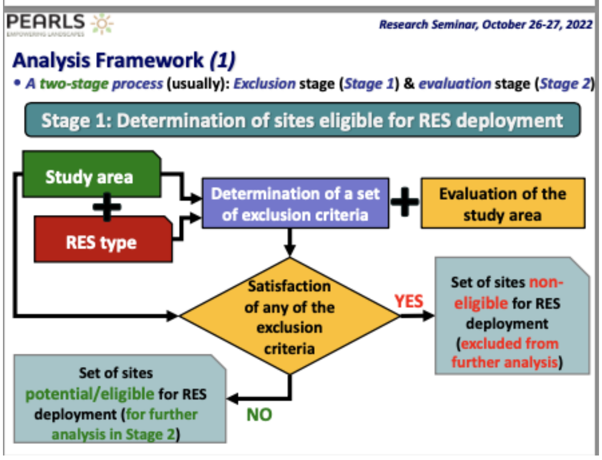
• A two-stage process (usually): Exclusion stage (Stage 1) & evaluation stage (Stage 2)
Stage 1: Determination of sites eligible for RES deployment
Study area
RES type
Determination of a set of exclusion criteria
Evaluation of the study area
Satisfaction of any of the exclusion criteria
YES
Set of sites non-eligible for RES deployment (excluded from further analysis)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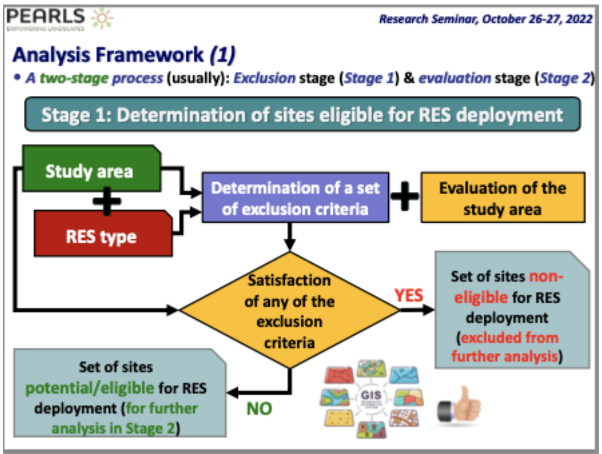
Analysis Framework (1)
• A two-stage process (usually): Exclusion stage (Stage 1) & evaluation stage (Stage 2)
Stage 1: Determination of sites eligible for RES deployment
Study area
RES type
Determination of a set of exclusion criteria
Evaluation of the study area
Satisfaction of any of the exclusion criteria
YES
Set of sites non-eligible for RES deployment (excluded from further analysis)
NO
Set of sites potential/eligible for RES deployment (for further analysis in Stage 2)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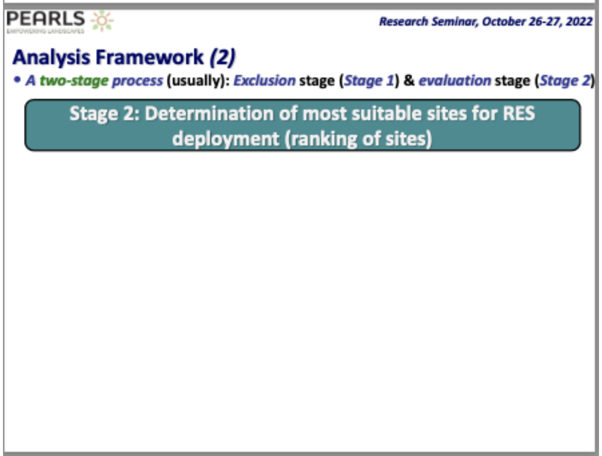
GIS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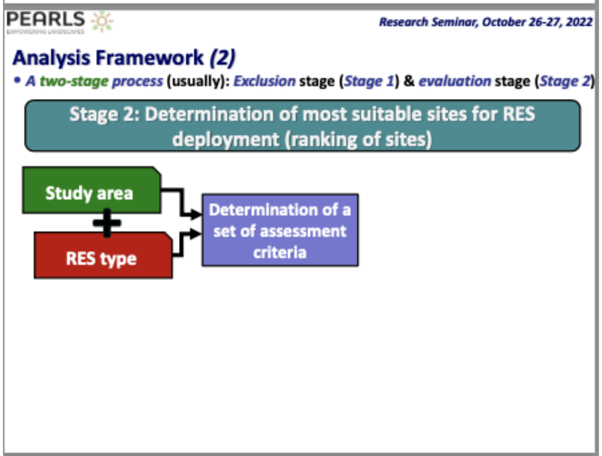
Analysis Framework (2)
• A two-stage process (usually): Exclusion stage (Stage 1) & evaluation stage (Stage 2)
Stage 2: Determination of most suitable sites for RES deployment (ranking of sites)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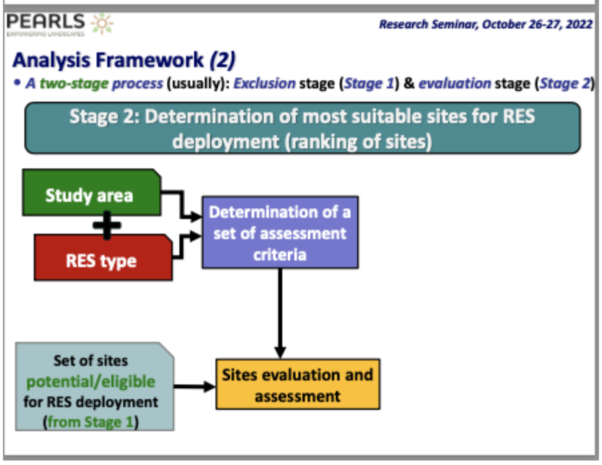
Analysis Framework (2)
• A two-stage process (usually): Exclusion stage (Stage 1) & evaluation stage (Stage 2)
Stage 2: Determination of most suitable sites for RES deployment (ranking of sites)
Study area
RES type
Determination of a set of assessment criteria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Analysis Framework (2)
• A two-stage process (usually): Exclusion stage (Stage 1) & evaluation stage (Stage 2)
Stage 2: Determination of most suitable sites for RES deployment (ranking of sites)
Study area
RES type
Determination of a set of assessment criteria
Set of sites potential/eligible for RES deployment (from Stage 1)
Sites evaluation and assessment

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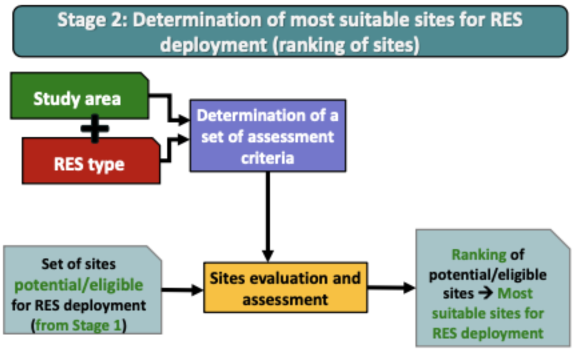
Analysis Framework *(2)*

- *A two-stage process* (usually): *Exclusion* stage (*Stage 1*) & *evaluation* stage (*Stage 2*)



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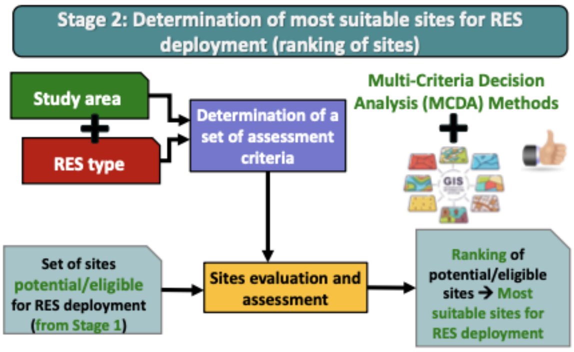
Analysis Framework *(2)*

- *A two-stage process* (usually): *Exclusion* stage (*Stage 1*) & *evaluation* stage (*Stage 2*)



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Siting Criteria: General

- *Siting criteria* (exclusion & assessment):
  - *Dependence* upon *RES type* and *study area* (sometimes and upon *data availability*)
  - *Description* of *technical, economic, environmental, legal* and *socio-political factors*
  - *Determination* based on *existing regulation*, *authorities requirements*, *experts* (e.g. spatial planners) *knowledge* and *expertise*, *best practices*, *literature*, *public opinion*

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Siting Criteria: Example of exclusion criteria for onshore wind projects*

Description	Frequency of Occurrence	Mean Value	Min/Max Value	Predominant Value(s)
Urban and residential areas	28	1125 m	0/3000 m	500 m
Protected environmental areas	24	550 m	0/2000 m	0 m
Proximity to road network	23	220 m 6335 m	0/500 m 2000/10,000 m	500 m N/a upper limit (10,000 m)
Civil/military aviation areas	22	4060 m	0/17,000 m	2500 and 3000 m
Slope of terrain	19	18.65%	10/57.7%	10%
Water surfaces	17	475 m	0/4000 m	100 and 400 m
Proximity to high-voltage electricity grid	16	160 m 7400 m	50/250 m 2000/10,000 m	100 and 250 m N/a upper limit (10,000 m)
Bird habitats and migration corridors	16	560 m	0/3000 m	0 m
Archeological, historical, and cultural heritage sites	14	990 m	0/3000 m	0, 500, and 1000 m
Wind velocity	12	5.20 m/s	4/6.5 m/s	5 m/s
Agricultural land	9	85 m	0/500 m	0 m
Protected landscapes	7	855 m	0/2000 m	1000 m
Elevation	7	1315 m	200/2000 m	2000 m
Military zones	6	1690 m	0/10,000 m	0 m
Touristic zones	6	750 m	0/1000 m	1000 m

* Spyridonidou S, Vagiona DG. Systematic Review of Site-Selection Processes in Onshore and Offshore Wind Energy Research. Energies. 2020; 13(22):5906. https://doi.org/10.3390/en13225906

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Siting Criteria: Example of exclusion criteria for offshore wind projects*

Description	Frequency of Occurrence	Mean Value	Min/Max Value	Predominant Value(s)
Water depth	18	33.5 m 175 m	5/62 m 20/1000 m	- 50 m
Protected environmental areas	18	780 m	0/3000 m	0 m
Verified shipping routes	14	1205 m	0/4800 m	0 m
Wind velocity	13	5.2 m/s	3/7 m/s	6 m/s
Military zones	11	45.45 m	0/500 m	0 m
Landscape protection/visual and acoustic disturbance	10	7335 m	1000/25,000 m	5000 m
Bird habitats and migration corridors	10	1050 m	0/3000 m	0 m
Pipelines and underwater cables	8	160 m	0/500 m	0 m
Proximity to local ports	7	82,145 m	20,000/200,000 m	100,000 m
Geographic boundaries	7	-	TW [1]/EEZ [1]	TW [1]
Other marine uses	7	DO [2]	DO [2]/DO [2]	DO [2]
Fishing areas	6	105 m	0/500 m	0 m
Proximity to high-voltage electricity grid	5	1000 m 60,000 m	1000/1000 m 20,000/100,000 m	1000 m -
Urban and residential areas	4	1250 m	1000/1500 m	-

[1] TW, territorial waters; and EEZ, exclusive economic zone as exclusion limits. [2] Depending on marine use.

* Spyridonidou S, Vagiona DG. Systematic Review of Site-Selection Processes in Onshore and Offshore Wind Energy Research. Energies. 2020; 13(22):5906. https://doi.org/10.3390/en13225906

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Siting Criteria: Example of assessment criteria for onshore wind projects* (1)

Description	Frequency of Occurrence	Mean Weight	Priority Position	Mean Optimal Value(s)	Mean Poor Value(s)
Wind velocity	22	37%	1° (94.45%)	≥8.47 m/s	≤5.20 m/s
Proximity to road network	22	12%	3° and last (35%)	≤955 m	≥6315 m
Proximity to high-voltage electricity grid	20	13%	2° (37.5%)	≤1495 m	≥9380 m
Urban and residential areas	17	12%	3° (35.70%)	≥4880 m	≤2010 m
Slope of terrain	15	10%	6° and penultimate (23.1%)	≤3.91%	≥22.90%
Protected environmental areas	11	10%	2° and last (50%)	≥1700 m	≤1060 m
Land cover	9	10%	2° (37.50%)	No [1] and/or [2]≥1335 m	Yes [1] and/or [2]≤935 m
Civil/military aviation areas	8	6%	Last (50%)	≥13,500 m	≤4915 m
Other land uses	7	18.85%	2° (33.33%)	Arid land [3]	N/a [3]
Wind power density	5	25.15%	1° (75%)	≥350 W/m^2	≤185 W/m^2

[1] No or yes for the presence of vegetation coverage and specific type of forests. [2] Distance from forests. [3] Optimal/poor land-use classes. No values applied. [4] No-, low- or high-agricultural-capacity land, and/or implementation of safety zone of these areas.

* Spyridonidou S, Vagiona DG. Systematic Review of Site-Selection Processes in Onshore and Offshore Wind Energy Research. Energies. 2020; 13(22):5906. https://doi.org/10.3390/en13225906

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Siting Criteria: Example of assessment criteria for onshore wind projects* (2)

Archeological/historical nd cultural heritage sites	5	8.10%	3° (75%)	≥1800 m	≤800 m
Elevation	5	7.50%	N/a	≤30 m	≥350 m
Bird habitats and migration corridors	5	5.95%	Last (100%)	≥12,000 m	≤2375 m
Landscape protection	5	8%	N/a	≥4000 m	≤1500 m
Water surfaces	4	5.12%	N/a	≥635 m	≤275 m
Visual impact	4	5.25%	5° (50%)	N/a	N/a
Areas with possibility of electromagnetic interference	3	N/a	N/a	≥2750 m	≤700 m
Agricultural land	3	4%	N/a	Low/no [4] and/or >2000 m	High [4] and/or ≤1000 m
Population density	2	10.04%	N/a	N/a	N/a
Electricity demand/consumption	2	12.85%	N/a	>154,440 MWh	≤3620 MWh
Touristic zones	2	6.40%	N/a	≥2200 m	≤800 m
Religious sites	2	N/a	N/a	>500 m	≤400 m
Proximity to coastline	2	N/a	N/a	>3000 m	≤100 m

[4] No-, low- or high-agricultural-capacity land, and/or implementation of safety zone of these areas.

* Spyridonidou S, Vagiona DG. Systematic Review of Site-Selection Processes in Onshore and Offshore Wind Energy Research. Energies. 2020; 13(22):5906. https://doi.org/10.3390/en13225906

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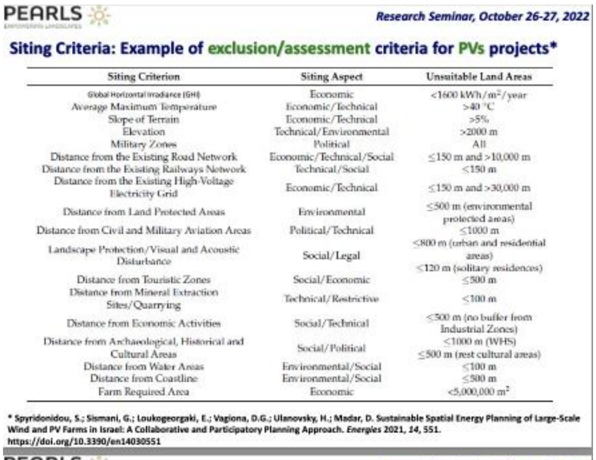
Siting Criteria: Example of assessment criteria for offshore wind projects*

Description	Frequency of Occurrence	Mean Weight	Priority Position	Mean Optimal Value(s)	Mean Poor Value(s)
Wind velocity	12	28.90%	1° (77.80%)	≥9.42 m/s	≤6.43 m/s
Water depth	9	18.35%	2° (37.50%)	≤42.5 m	≥182 m
Proximity to high-voltage electricity grid	9	14.85%	3° and 5° (25%)	≤18,375 m	≥135,845 m
Protected environmental areas	8	11%	Last (42.90%)	≥20,835 m	≤6700 m
Proximity to local ports	6	10%	N/a	≤29,375 m	≥63,000 m
Verified shipping routes	6	6.50%	3° and last (40%)	>3704 m or low SD [1]	≤1852 m or high SD [1]
Landscape protection/visual and acoustic disturbance	5	11.80%	Penultimate (50%)	≥15,555 m	≤2520 m
Wind energy potential	4	N/a	N/a	>166,029 MWh/year and/or ≥770 MW	≤105,232 MWh/year and/or ≤20 MW
Fishing habitats/activity and marine species habitats	4	5.70%	N/a	N/a	N/a
Wind power density	3	N/a	N/a	≥675 W/m^2	≤45 W/m^2
Military exercise areas	3	6%	N/a	>60,000 m	≤20,000 m
Population served	3	13.55%	N/a	N/a	N/a
Distance from the shore (for economic purposes)	3	9%	3° (67%)	≤25,750 m	≥200,000 m
Bird habitats and migration corridors	2	N/a	N/a	N/a	N/a
Total investment cost	2	15.60%	2° (100%)	N/a	N/a

[1] Low or high degree of shipping density (SD)

* Spyridonidou S, Vagiona DG. Systematic Review of Site-Selection Processes in Onshore and Offshore Wind Energy Research. Energies. 2020; 13(22):5906. https://doi.org/10.3390/en13225906



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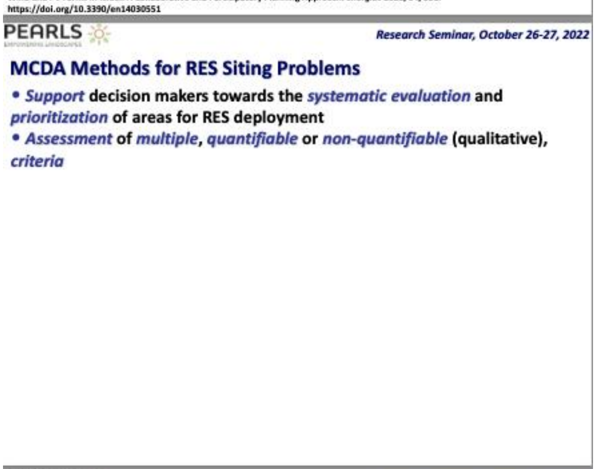
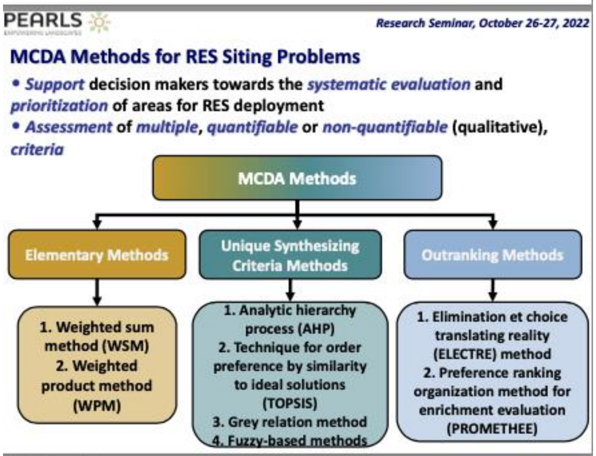
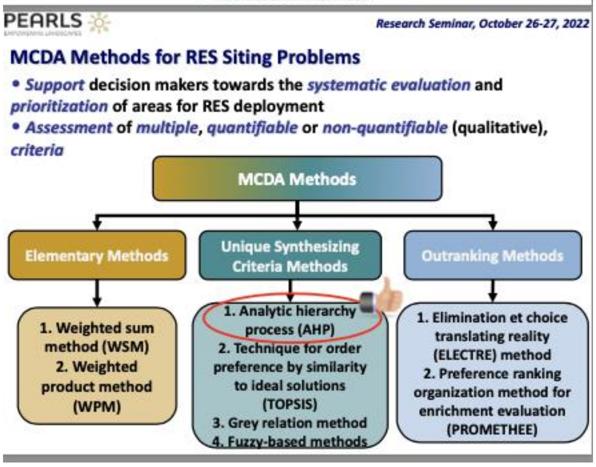
Siting Criteria: Example of exclusion/assessment criteria for PVs projects*

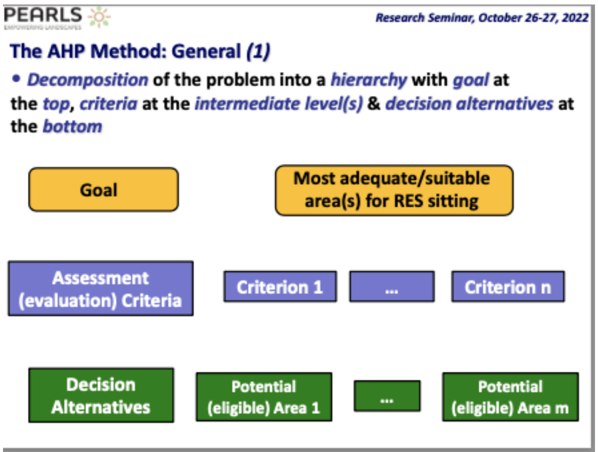
Siting Criterion	Siting Aspect	Unsuitable Land Areas
Global Horizontal Irradiance (GHI)	Economic	<1600 kWh/m²/year
Average Maximum Temperature	Economic/Technical	>40 °C
Slope of Terrain	Economic/Technical	>5%
Elevation	Technical/Environmental	>2000 m
Military Zones	Political	All
Distance from the Existing Road Network	Economic/Technical/Social	≤150 m and >10,000 m
Distance from the Existing Railways Network	Technical/Social	≤150 m
Distance from the Existing High-Voltage Electricity Grid	Economic/Technical	≤150 m and >30,000 m
Distance from Land Protected Areas	Environmental	≤500 m (environmental protected areas)
Distance from Civil and Military Aviation Areas	Political/Technical	≤1000 m
Landscape Protection/Visual and Acoustic Disturbance	Social/Legal	≤800 m (urban and residential areas) ≤120 m (solitary residences)
Distance from Touristic Zones	Social/Economic	≤500 m
Distance from Mineral Extraction Sites/Quarrying	Technical/Restrictive	≤100 m
Distance from Economic Activities	Social/Technical	≤500 m (no buffer from Industrial Zones)
Distance from Archaeological, Historical and Cultural Areas	Social/Political	≤1000 m (WHS) ≤500 m (rest cultural areas)
Distance from Water Areas	Environmental/Social	≤100 m
Distance from Coastline	Environmental/Social	≤500 m
Farm Required Area	Economic	<5,000,000 m²

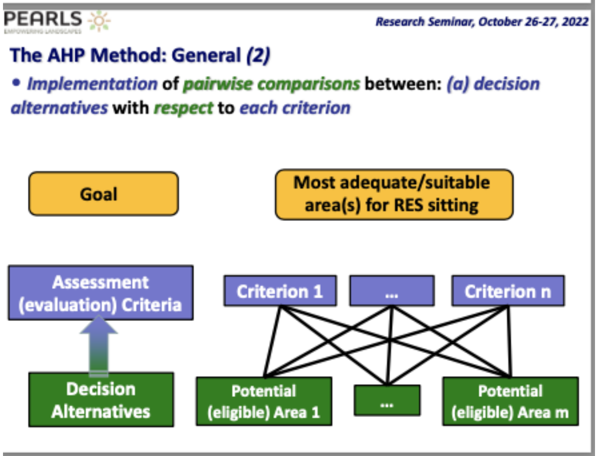
* Spyridonidou, S.; Sismani, G.; Loukogeorgaki, E.; Vagiona, D.G.; Ulanovsky, H.; Madar, D. Sustainable Spatial Energy Planning of Large-Scale Wind and PV Farms in Israel: A Collaborative and Participatory Planning Approach. *Energies* 2021, *14*, 551. https://doi.org/10.3390/en14030551

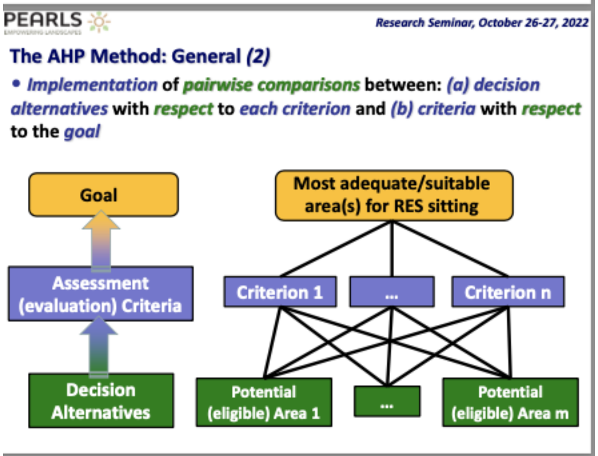


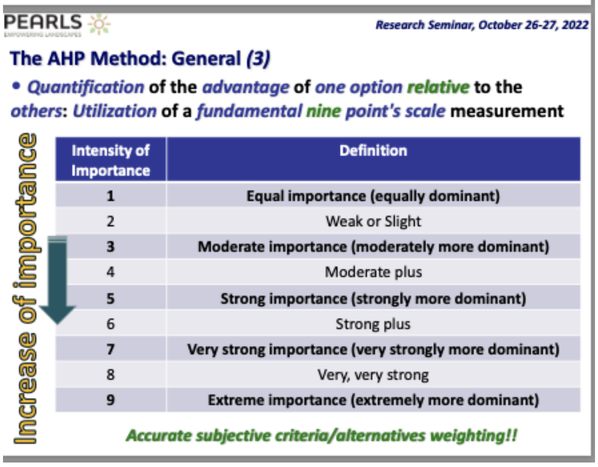












Intensity of Importance	Definition
1	Equal importance (equally dominant)
2	Weak or Slight
3	Moderate importance (moderately more dominant)
4	Moderate plus
5	Strong importance (strongly more dominant)
6	Strong plus
7	Very strong importance (very strongly more dominant)
8	Very, very strong
9	Extreme importance (extremely more dominant)

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The AHP Method: Steps *(1)*

Step 1: ***Implementation*** **of** ***pairwise comparisons*** **(experts groups, stakeholders and/or the public could contribute, especially for assessment criteria comparisons)**

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The AHP Method: Steps *(1)*

Step 1: ***Implementation*** **of** ***pairwise comparisons*** **(experts groups, stakeholders and/or the public could contribute, especially for assessment criteria comparisons)**

Step 2: ***Pairwise comparisons*** **at a** ***given level*** **→ Creation of the corresponding** ***judgment matrix*** **A**

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The AHP Method: Steps *(1)*

Step 1: ***Implementation*** **of** ***pairwise comparisons*** **(experts groups, stakeholders and/or the public could contribute, especially for assessment criteria comparisons)**

Step 2: ***Pairwise comparisons*** **at a** ***given level*** **→ Creation of the corresponding** ***judgment matrix*** **A**

For example, assuming *n* *assessment criteria*, A (for the criteria with respect to the goal) takes the form:

$$\mathbf{A}=\begin{pmatrix} a_{11} & \dots & a_{1j} & \dots & a_{1n} \\ \dots & \dots & \dots & \dots & \dots \\ a_{i1} & \dots & a_{ij} & \dots & a_{in} \\ \dots & \dots & \dots & \dots & \\ a_{n1} & \dots & a_{nj} & \dots & a_{nn} \end{pmatrix}$$

a_{ij}: ***Importance*** of ***criterion i over criterion j*** with ***respect*** to the ***goal***

Reciprocal judgement: $a_{ji}=1/a_{ij}$ and $a_{ij}=1$ for $i=j$

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The AHP Method: Steps *(2)*

Step 3: ***Creation*** **of a** ***normalized comparison matrix*** **NC (for each judgment matrix) by dividing each element in the judgement matrix by its column sum**

For the *n* *assessment criteria*, NC takes the form:

$$\mathbf{NC}=\begin{pmatrix} \frac{a_{11}}{\sum_i a_{i1}} & \dots & \frac{a_{1j}}{\sum_i a_{ij}} & \dots & \frac{a_{1n}}{\sum_i a_{in}} \\ \dots & \dots & \dots & \dots & \dots \\ \frac{a_{i1}}{\sum_i a_{i1}} & \dots & \frac{a_{ij}}{\sum_i a_{ij}} & \dots & \frac{a_{in}}{\sum_i a_{in}} \\ \dots & \dots & \dots & \dots & \\ \frac{a_{n1}}{\sum_i a_{i1}} & \dots & \frac{a_{nj}}{\sum_i a_{ij}} & \dots & \frac{a_{nn}}{\sum_i a_{in}} \end{pmatrix}$$

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The AHP Method: Steps *(3)*

Step 4: ***Formation*** of the ***priority vector*** w (for each normalized comparison matrix) by computing the average of the elements in each row of the normalized matrix

Priority vector for ***assessment criteria***: ***Importance*** of each criterion and ***influence*** of each criterion on the ***overall goal***

Priority vector for ***decision alternatives***: ***Importance*** of each alternative with respect to ***each criterion***

For the *n* ***assessment criteria***, w takes the form:

$$\mathbf{w}=\begin{pmatrix} w_1 \\ \cdots \\ w_i \\ \cdots \\ w_n \end{pmatrix}=\begin{pmatrix} \left(\frac{a_{11}}{\sum_i a_{i1}}+\ldots+\frac{a_{1j}}{\sum_i a_{ij}}+\ldots+\frac{a_{1n}}{\sum_i a_{in}}\right)/n \\ \cdots \\ \left(\frac{a_{i1}}{\sum_i a_{i1}}+\ldots+\frac{a_{ij}}{\sum_i a_{ij}}+\ldots+\frac{a_{in}}{\sum_i a_{in}}\right)/n \\ \cdots \\ \left(\frac{a_{n1}}{\sum_i a_{i1}}+\ldots+\frac{a_{nj}}{\sum_i a_{ij}}+\ldots+\frac{a_{nn}}{\sum_i a_{in}}\right)/n \end{pmatrix}$$

w_i, $i=1,\ldots,n$: ***relative weights*** of the ***assessment criteria***

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The AHP Method: Steps *(4)*

Step 5: ***Check*** the ***degree*** of ***consistency*** of each ***matrix*** A by calculating ***the Consistency Index (CI)*** and the ***Consistency Ratio (CR)***

For the *n* ***assessment criteria***, we have:

$$CI = \frac{\lambda_{max} - n}{n-1} \quad \text{and} \quad CR = \frac{CI}{RI}$$

λ_{max}: maximum eigenvalue (A X **w**=λ_{max} X **w**)
RI: random index value depending depends on the matrix size

- ***CR should be < 0.1***
- ***CR≥ 0.1***: the ***matrix*** is considered ***inconsistent*** and ***judgments*** should be ***repeated***

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The AHP Method: Steps *(5)*

Step 6: ***Formation*** of the ***overall priority scale*** by multiplying local (alternatives') priorities by the priority of the corresponding criterion in the level above and adding

For the *n* ***assessment criteria*** and *m* alternatives, we have:

Priority vector of assessment criteria

	w_1	...	w_i	...	w_n	Overall priority
Alternative 1	w_{11}	...	w_{1i}	...	w_{1n}	$w_{11}*w_1+\ldots+w_{1i}*w_i+\ldots+w_{1n}*w_n$
...	...	...	...	...	...	...
Alternative *m*	w_{m1}	...	w_{mi}	...	w_{mn}	$w_{m1}*w_1+\ldots+w_{mi}*w_i+\ldots+w_{mn}*w_n$

Priority vector of Alternative 1

Priority vector of Alternative *m*

w_{mn}: ***relative weight*** of ***alternative*** *m* with respect to the *n* ***assessment criterion***

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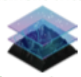
Geographical Information Systems (GIS)

- ***GIS***: ***Creation***, ***management***, ***analysis***, ***synthesis*** and ***mapping*** of various types of ***data***
- ***In RES sitting problems***:
  - ***Creation*** of ***GIS database*** for ***exclusion*** and ***assessment criteria***
  - ***Mapping (thematic maps)*** of ***exclusion*** and ***assessment criteria*** (***spatial data visualization***)
  - ***Contribution*** to the ***assessment*** of the ***various alternatives*** (eligible areas) with respect to ***assessment criteria*** (support the formation of the corresponding judgment matrices in AHP)
  - ***Support*** the ***participation*** of ***public*** or ***experts*** or ***stakeholders*** on the ***importance assessment*** of ***criteria*** and/or of the ***alternatives*** with respect to the criteria
  - ***Visual impact assessment*** & ***quantification***
  - ***Alternatives*** (eligible areas) ***visualization***



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Site Selection of HOWiWaES in Greece (application example): General *(1)*

- ***Objective*: *Site selection* of *Hybrid Offshore Wind and Wave Energy Systems* (*HOWiWaES*) in *Greece****

Why HoWiWaES?

* Vasileiou, M.; Loukogeorgaki, E.; Vagiona D.G. GIS-based Multi-criteria Decision Analysis for Site Selection of Hybrid Offshore Wind and Wave Energy Systems in Greece. Renewable and Sustainable Energy Reviews 2017, 73C, 745-757

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Why HoWiWaES?

✓ *Rapid development*
✓ *Many large-scale commercial projects*

✓ *One* of the *most advanced* & *rapidly developed* ocean energy technologies
✗ Still *many technological barriers* to be *competitive*

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Common objective of offshore wind and wave energy sector: Associated *costs' reduction*

* Vasileiou, M.; Loukogeorgaki, E.; Vagiona D.G. GIS-based Multi-criteria Decision Analysis for Site Selection of Hybrid Offshore Wind and Wave Energy Systems in Greece. Renewable and Sustainable Energy Reviews 2017, 73C, 745-757

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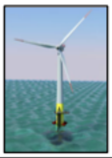
Site Selection of HOWiWaES in Greece (application example): General *(2)*

- ***Objective*: *Site selection* of *Hybrid Offshore Wind and Wave Energy Systems* (*HOWiWaES*) in *Greece***

Why HoWiWaES?

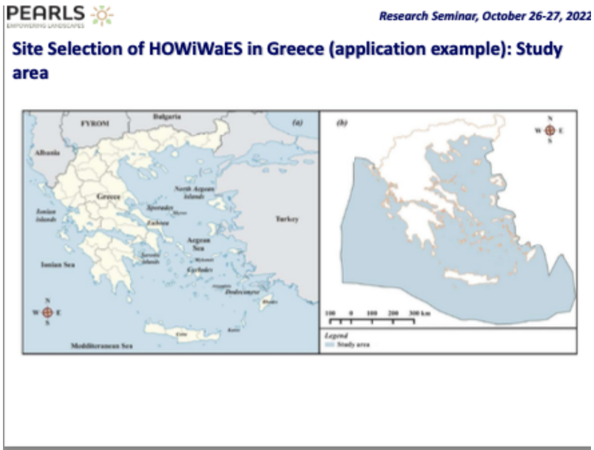


HOWiWaES (*OWTs* with *WECs combined* in *one structure* for *simultaneous offshore wind* and *wave energy exploitation*):

✓ *Contribution* to costs' *reduction*

✓ *Offer* of *additional advantages* (e.g. *increased energy yield*, *smooth* and *highly available power output*, *common grid infrastructure* etc.)

* Vasileiou, M.; Loukogeorgaki, E.; Vagiona D.G. GIS-based Multi-criteria Decision Analysis for Site Selection of Hybrid Offshore Wind and Wave Energy Systems in Greece. Renewable and Sustainable Energy Reviews 2017, 73C, 745-757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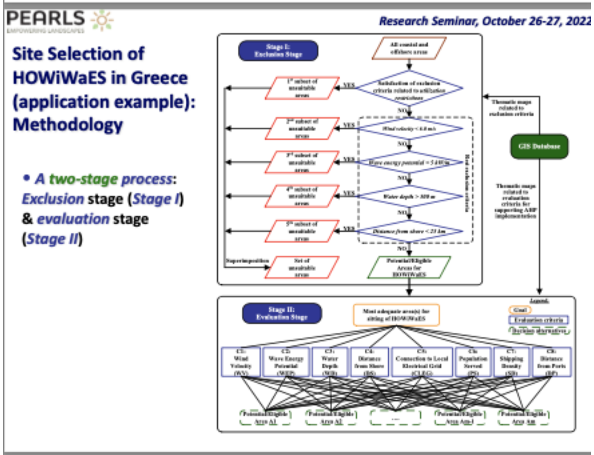
Site Selection of HOWiWaES in Greece (application example): Study area
(a)
(b)
Legend
Study area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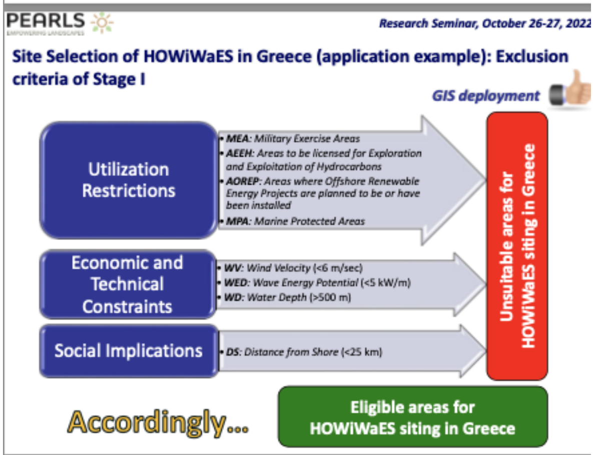
Site Selection of HOWiWaES in Greece (application example): Methodology
• A two-stage process: Exclusion stage (Stage I) & evaluation stage (Stage II)
Stage I: Exclusion Stage
Stage II: Evaluation Stage
GIS Database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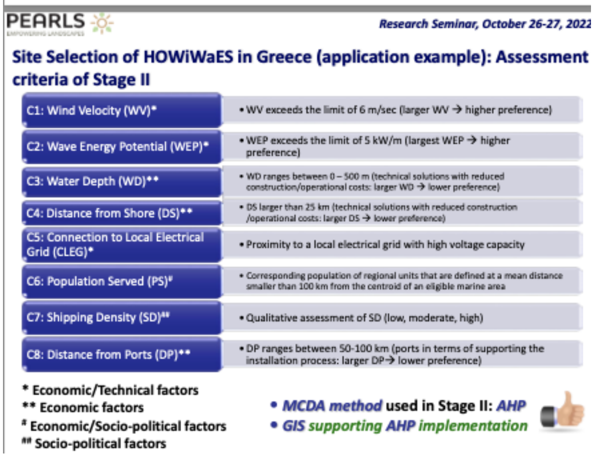
Site Selection of HOWiWaES in Greece (application example): Exclusion criteria of Stage I
GIS deployment
Utilization Restrictions
• MEA: Military Exercise Areas
• AEEH: Areas to be licensed for Exploration and Exploitation of Hydrocarbons
• AOREP: Areas where Offshore Renewable Energy Projects are planned to be or have been installed
• MPA: Marine Protected Areas
Economic and Technical Constraints
• WV: Wind Velocity (<6 m/sec)
• WED: Wave Energy Potential (<5 kW/m)
• WD: Water Depth (>500 m)
Social Implications
• DS: Distance from Shore (<25 km)
Unsuitable areas for HOWiWaES siting in Greece
Accordingly...
Eligible areas for HOWiWaES siting in Greece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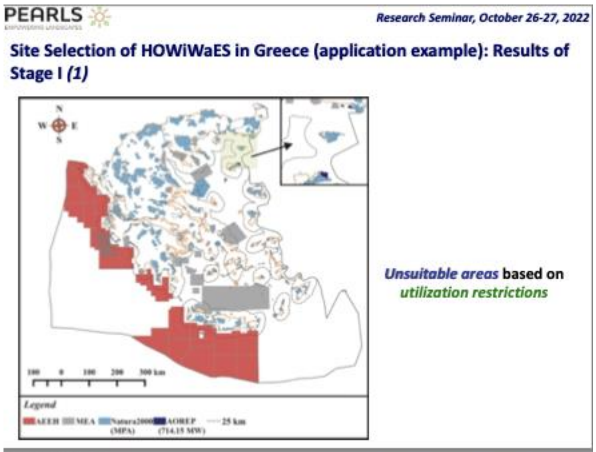
Site Selection of HOWiWaES in Greece (application example): Assessment criteria of Stage II
C1: Wind Velocity (WV)*
• WV exceeds the limit of 6 m/sec (larger WV → higher preference)
C2: Wave Energy Potential (WEP)*
• WEP exceeds the limit of 5 kW/m (largest WEP → higher preference)
C3: Water Depth (WD)**
• WD ranges between 0 – 500 m (technical solutions with reduced construction/operational costs: larger WD → lower preference)
C4: Distance from Shore (DS)**
• DS larger than 25 km (technical solutions with reduced construction /operational costs: larger DS → lower preference)
C5: Connection to Local Electrical Grid (CLEG)*
• Proximity to a local electrical grid with high voltage capacity
C6: Population Served (PS)#
• Corresponding population of regional units that are defined at a mean distance smaller than 100 km from the centroid of an eligible marine area
C7: Shipping Density (SD)##
• Qualitative assessment of SD (low, moderate, high)
C8: Distance from Ports (DP)**
• DP ranges between 50-100 km (ports in terms of supporting the installation process: larger DP → lower preference)
* Economic/Technical factors
** Economic factors
# Economic/Socio-political factors
Socio-political factors
• MCDA method used in Stage II: AHP
• GIS supporting AHP implementation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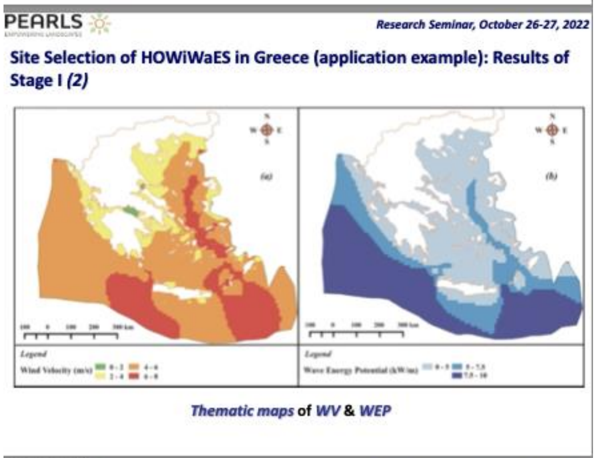
Site Selection of HOWiWaES in Greece (application example): Results of Stage I (1)
Unsuitable areas based on utilization restrictions
Legend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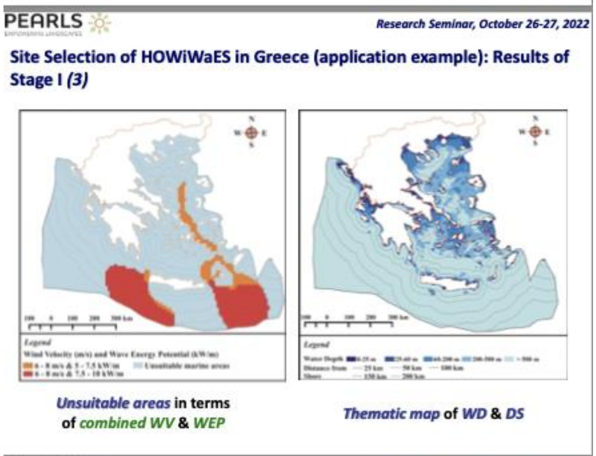
Site Selection of HOWiWaES in Greece (application example): Results of Stage I (2)
Thematic maps of WV & WEP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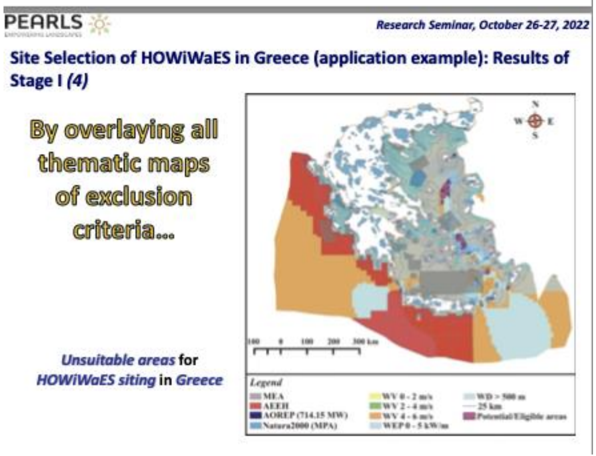
Site Selection of HOWiWaES in Greece (application example): Results of Stage I (3)
Unsuitable areas in terms of combined WV & WEP
Thematic map of WD & DS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Site Selection of HOWiWaES in Greece (application example): Results of Stage I (4)
By overlaying all thematic maps of exclusion criteria…
Unsuitable areas for HOWiWaES siting in Greece
Legend

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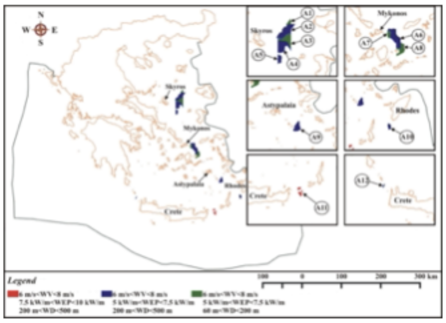
Site Selection of HOWiWaES in Greece (application example): Results of Stage I *(5)*

and...

Eligible areas (12) for *HOWiWaES siting* in *Greece*



- ✓ Offshore areas *West* & *East* of *Crete*
- ✓ Offshore areas in a *lengthwise zone* from *North-central* to *central Aegean*

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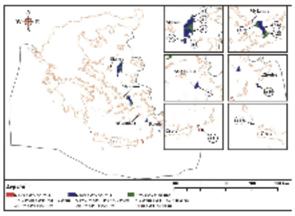
Site Selection of HOWiWaES in Greece (application example): Results of Stage I *(6)*



Eligible areas (12) for *HOWiWaES siting* in *Greece*

Area	Geographical Location	Size (km^2)
A1	North-East (NE) of Skyros	45.77
A2	East-North-East (ENE) of Skyros	467.33
A3	East (E) of Skyros	283.27
A4	South-East (SE) of Skyros	427.7
A5	South-South-East (SSE) of Skyros	113.19
A6	East-South-East (ESE) of Mykonos	516.86
A7	East (E) of Mykonos	88.37
A8	South-East (SE) of Mykonos	212.48
A9	South-East (SE) of Astypalaia	192.32
A10	South-West (SW) of Rhodes	86.56
A11	East (E) of Crete	81.32
A12	North-West (NW) of Crete	21.12

Eligible areas determination affected by the *existence* of *very large WDs* (> 500 m) → marine areas *with a vast wind and wave energy potential excluded* due to *spatial constraints* resulting from *very deep water conditions*

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Site Selection of HOWiWaES in Greece (application example): Results of Stage II *(1)*

	C1	C2	C3	C4	C5	C6	C7	C8
C1	1	1	3	5	5	5	7	9
C2	1	1	3	5	5	5	7	9
C3	1/3	1/3	1	3	3	3	5	7
C4	1/5	1/5	1/3	1	1/3	1/3	3	3
C5	1/5	1/5	1/3	3	1	3	3	5
C6	1/5	1/5	1/3	3	1/3	1	3	5
C7	1/7	1/7	1/5	1/3	1/3	1/3	1	3
C8	1/9	1/9	1/7	1/3	1/5	1/5	1/3	1

Pairwise comparison of the *8 evaluation criteria* with respect to the *goal*

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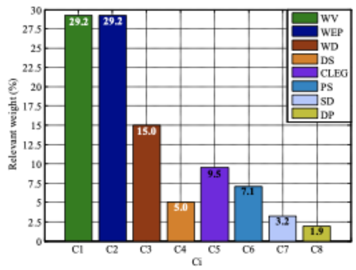
Site Selection of HOWiWaES in Greece (application example): Results of Stage II *(2)*



Relative weights of the *8 evaluation criteria* with respect to the *goal*

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Site Selection of HOWiWaES in Greece (application example): Results of Stage II *(3)*

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
A1	1	1	1	1	1	1	1	1	1	1	1/3	1
A2	1	1	1	1	1	1	1	1	1	1	1/3	1
A3	1	1	1	1	1	1	1	1	1	1	1/3	1
A4	1	1	1	1	1	1	1	1	1	1	1/3	1
A5	1	1	1	1	1	1	1	1	1	1	1/3	1
A6	1	1	1	1	1	1	1	1	1	1	1/3	1
A7	1	1	1	1	1	1	1	1	1	1	1/3	1
A8	1	1	1	1	1	1	1	1	1	1	1/3	1
A9	1	1	1	1	1	1	1	1	1	1	1/3	1
A10	1	1	1	1	1	1	1	1	1	1	1/3	1
A11	3	3	3	3	3	3	3	3	3	3	1	3
A12	1	1	1	1	1	1	1	1	1	1	1/3	1

Pairwise comparison **of the *12 eligible areas* with respect to *C2 (WEP)***

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Site Selection of HOWiWaES in Greece (application example): Results of Stage II *(4)*

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
A1	1	3	1	3	3	3	1	1	3	3	3	3
A2	1/3	1	1/3	1	1	1	1/3	1/3	1	1	1	1
A3	1	3	1	3	3	3	1	1	3	3	3	3
A4	1/3	1	1/3	1	1	1	1/3	1/3	1	1	1	1
A5	1/3	1	1/3	1	1	1	1/3	1/3	1	1	1	1
A6	1/3	1	1/3	1	1	1	1/3	1/3	1	1	1	1
A7	1	3	1	3	3	3	1	1	3	3	3	3
A8	1	3	1	3	3	3	1	1	3	3	3	3
A9	1/3	1	1/3	1	1	1	1/3	1/3	1	1	1	1
A10	1/3	1	1/3	1	1	1	1/3	1/3	1	1	1	1
A11	1/3	1	1/3	1	1	1	1/3	1/3	1	1	1	1
A12	1/3	1	1/3	1	1	1	1/3	1/3	1	1	1	1

Pairwise comparison **of the *12 eligible areas* with respect to *C3 (WD)***

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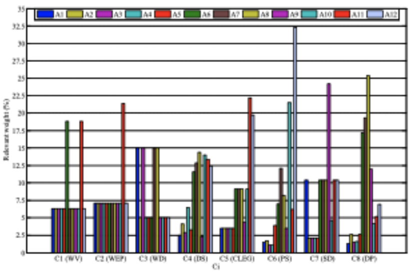
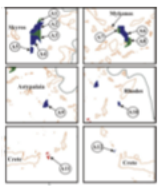
Site Selection of HOWiWaES in Greece (application example): Results of Stage II *(5)*





Relative weights **of the *12 eligible marine areas* with respect to each *assessment criterion***

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Site Selection of HOWiWaES in Greece (application example): Results of Stage II *(6)*

Ranking	Decision alternative	Preference percentage (%)
1	A11	16.1
2	A6	10.9
3	A12	9.9
4	A7	9.3
5	A8	9.2
6	A10	8.0
7	A1	7.0
8	A3	6.7
9	A9	6.5
10	A5	5.6
11	A4	5.5
12	A2	5.4

Ranking **of the *12 eligible marine areas***

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Site Selection of HOWiWaES in Greece (application example): Results of Stage II *(7)*

Ranking	Decision alternative	Preference percentage (%)
1	**A11**	**16.1**
2	A6	10.9
3	A12	9.9
4	A7	9.3
5	A8	9.2
6	A10	8.0
7	A1	7.0
8	A3	6.7
9	A9	6.5
10	A5	5.6
11	A4	5.5
12	A2	5.4

- ✓ *Simultaneous existence* of the *largest wind* & *wave energy potential*
- ✓ *Proximity* to a *high voltage capacity grid*
- ✓ *Existence* of a *quite small DS*

Ranking of the *12 eligible marine areas*

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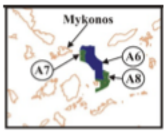
Site Selection of HOWiWaES in Greece (application example): Results of Stage II *(8)*

Ranking	Decision alternative	Preference percentage (%)
1	A11	16.1
2	**A6**	**10.9**
3	A12	9.9
4	**A7**	**9.3**
5	**A8**	**9.2**
6	A10	8.0
7	A1	7.0
8	A3	6.7
9	A9	6.5
10	A5	5.6
11	A4	5.5
12	A2	5.4

- ✓ *Significant wind* & *wave energy potential*
- ✓ *Satisfaction* of *important economic* factors (e.g. DS, WD)



Ranking of the *12 eligible marine areas*

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Site Selection of HOWiWaES in Greece (application example): Results of Stage II *(9)*

Ranking	Decision alternative	Preference percentage (%)
1	A11	16.1
2	A6	10.9
3	**A12**	**9.9**
4	A7	9.3
5	A8	9.2
6	A10	8.0
7	A1	7.0
8	A3	6.7
9	A9	6.5
10	A5	5.6
11	A4	5.5
12	A2	5.4

- ✓ *Satisfaction* of *economic/technical* (proximity to local grid) & *economic/socio-political* (population served) *factors*

Ranking of the *12 eligible marine areas*

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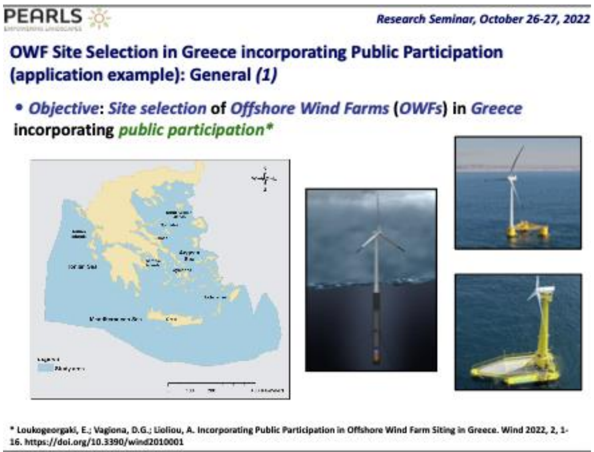
What about public (citizens') participation in the decision-making process?

Social accepted – Sustainable solutions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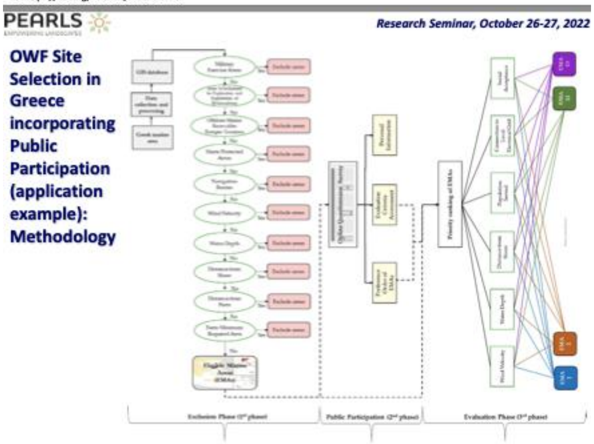
OWF Site Selection in Greece incorporating Public Participation (application example): General (1)
• Objective: Site selection of Offshore Wind Farms (OWFs) in Greece incorporating public participation*
* Loukogeorgaki, E.; Vagiona, D.G.; Lioliou, A. Incorporating Public Participation in Offshore Wind Farm Siting in Greece. Wind 2022, 2, 1-16. https://doi.org/10.3390/wind2010001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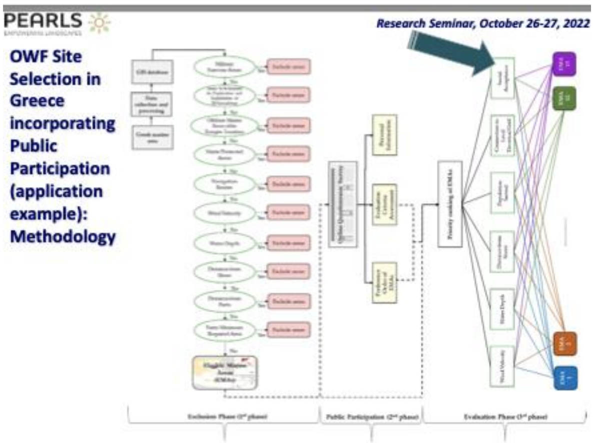
OWF Site Selection in Greece incorporating Public Participation (application example): Methodology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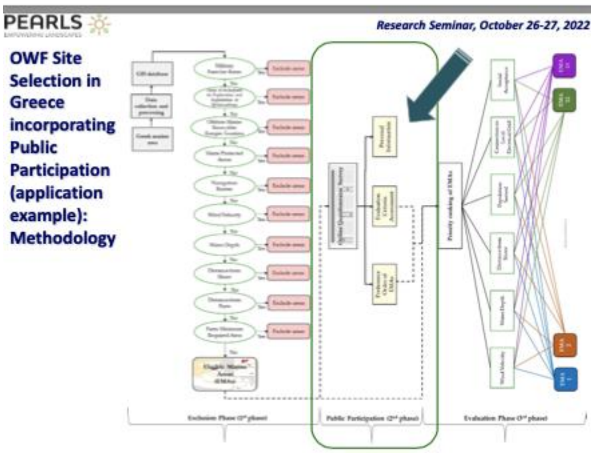
OWF Site Selection in Greece incorporating Public Participation (application example): Methodology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OWF Site Selection in Greece incorporating Public Participation (application example): Methodology

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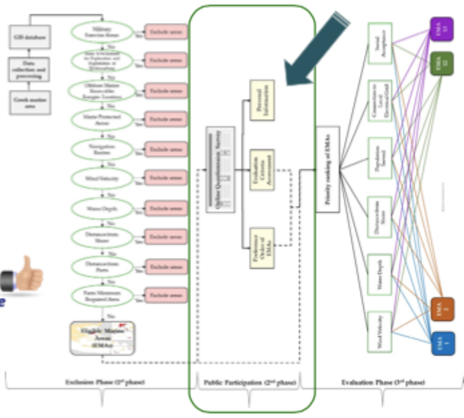
OWF Site Selection in Greece incorporating Public Participation (application example): Methodology



- ***Online Questionnaire Survey (OQS)***

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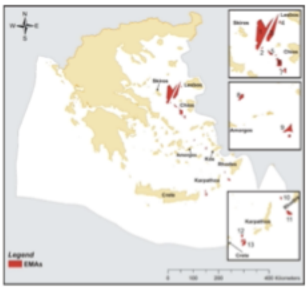
OWF Site Selection in Greece incorporating Public Participation (application example): Results of Phase I



Eligible areas (13) **for *OWFs siting* in *Greece***

No	Geographical Location	Size (km^2)
1	East of Skiros	1,343
2	South-East of Skiros	15.03
3	South-West of Lesvos	554.20
4	South-West of Lesvos	21.96
5	East of Chios	62.73
6	South-East of Chios	192.66
7	South-South-East of Chios	64.76
8	North-East of Amorgos	16.80
9	North-West of Kos	39.01
10	South-West of Rhodes	14.66
11	South-South-West of Rhodes	58.89
12	East-North-East of Crete	17.94
13	East of Crete	66.75

- ✓ ***7 first EMAs*** **(91.3% of the total EMAs area) in *North Aegean* (offshore of Skiros, Lesvos & Chios)**
- ✓ ***EMA8*** **in *central Aegean***
- ✓ ***Last 5 EMAs*** **(8.0% of the total EMAs area in *South-East Aegean* (offshore of Kos, Rhodes & Crete)**

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OWF Site Selection in Greece incorporating Public Participation (application example): Results of Phase II *(1)*

- ***OQS*: *122 questionnaires fully completed* by the *public* (Greek residents)**
  - ***77 (63%) engineers* of *various specialties***
  - ***73 (~60%) engineers* of various specialties working though *only* in the RES sector**
  - ***11 (9%)* were *residents* of Greek islands**
  - ***Identification* of *3 different focus groups***

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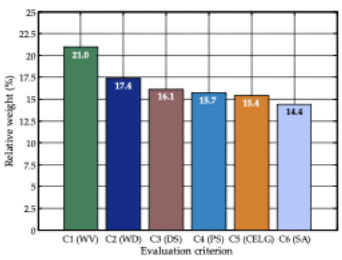
OWF Site Selection in Greece incorporating Public Participation (application example): Results of Phase II *(2)*



- ***C1 (WV)*: Wind Velocity**
- ***C2 (WD)*: Water Depth**
- ***C3 (DS)*: Distance to Shore**
- ***C4 (PS)*: Population Served**
- ***C5 (CLEG)*: Connection to Local Electrical Grid**
- ***C6 (SA)*: Social Acceptance (estimates the citizens' preferences for EMAs)**

Relative weights* of the *6 evaluation criteria* with respect to the *goal* according to *public preferences

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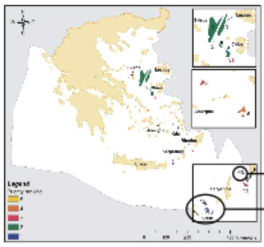
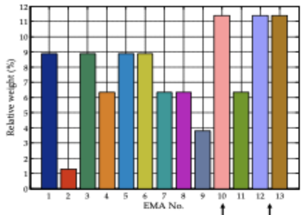
OWF Site Selection in Greece incorporating Public Participation (application example): Results of Phase II *(3)*



Ranking of *EMAs* according to *public preference*



Relative weights of *EMAs* with respect to *Social Acceptance (SA) criterion (C6)*

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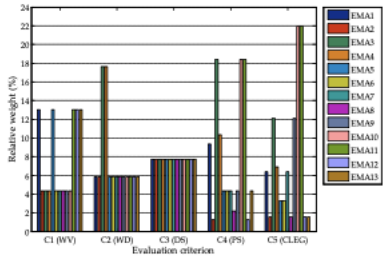
OWF Site Selection in Greece incorporating Public Participation (application example): Results of Phase III *(1)*



Relative weights of the *13 EMAs* with respect to each *assessment criterion (C1-C5)*

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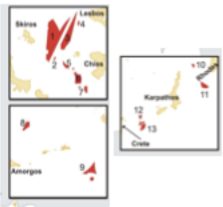
OWF Site Selection in Greece incorporating Public Participation (application example): Results of Phase III *(2)*

Ranking	EMA	Preference percentage (%)
1	EMA11	12.2
2	EMA3	11.3
3	EMA10	11.1
4	EMA4	8.8
5	EMA1	8.7
6	EMA13	7.6
7	EMA5	7.5
8	EMA12	7.1
9	EMA9	6.3
10	EMA7	5.8
11	EMA6	5.7
12	EMA8	4.7
13	EMA2	3.8



Ranking of the *13 EMAs*

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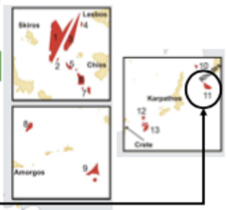
OWF Site Selection in Greece incorporating Public Participation (application example): Results of Phase III *(2)*

Ranking	EMA	Preference percentage (%)
1	**EMA11**	**12.2**
2	EMA3	11.3
3	EMA10	11.1
4	EMA4	8.8
5	EMA1	8.7
6	EMA13	7.6
7	EMA5	7.5
8	EMA12	7.1
9	EMA9	6.3
10	EMA7	5.8
11	EMA6	5.7
12	EMA8	4.7
13	EMA2	3.8



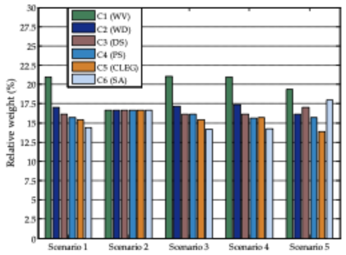
- ✓ *Large WV* (in the range of 6.5-7.5 m/s)
- ✓ *Close proximity* to *local grid* of *high capacity*
- ✓ *Potential* to serve a *large population.*

Ranking of the *13 EMAs*

PEARLS

Research Seminar, October 26-27, 2022

OWF Site Selection in Greece incorporating Public Participation (application example): Sensitivity Analysis *(1)*



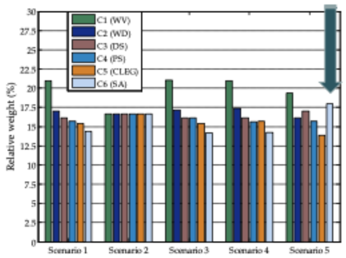
Relative weights **of the** ***6 evaluation criteria*** **with respect to the** ***goal*** **for the** ***five scenarios*** **of the** ***sensitivity analysis***

- ***Scenario 1***: ***All*** **OQS participants responses (baseline scenario)**
- ***Scenario 2***: ***Equal weights*** **assignment (6.7%)**
- ***Scenario 3***: ***OQS responses*** **from** ***engineers*** **working** ***only*** **in the** ***RES sector*** **(1st focus group)**
- ***Scenario 4***: ***OQS responses*** **from** ***engineers*** **(2nd focus group)**
- ***Scenario 5***: ***OQS responses only*** **from** ***islands residents*** **(3rd focus group)**

PEARLS

Research Seminar, October 26-27, 2022

OWF Site Selection in Greece incorporating Public Participation (application example): Sensitivity Analysis *(1)*



Relative weights **of the** ***6 evaluation criteria*** **with respect to the** ***goal*** **for the** ***five scenarios*** **of the** ***sensitivity analysis***

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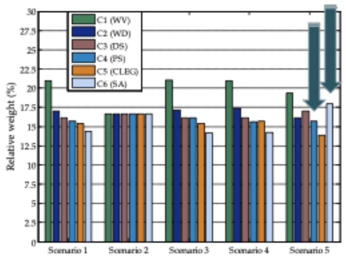
- ***Scenario 4***: ***OQS responses*** **from** ***engineers*** **(2nd focus group)**
- ***Scenario 5***: ***OQS responses only*** **from** ***islands residents*** **(3rd focus group)**

PEARLS

Research Seminar, October 26-27, 2022

OWF Site Selection in Greece incorporating Public Participation (application example): Sensitivity Analysis *(1)*



Relative weights **of the** ***6 evaluation criteria*** **with respect to the** ***goal*** **for the** ***five scenarios*** **of the** ***sensitivity analysis***

- ***Scenario 1***: ***All*** **OQS participants responses (baseline scenario)**
- ***Scenario 2***: ***Equal weights*** **assignment (6.7%)**
- ***Scenario 3***: ***OQS responses*** **from** ***engineers*** **working** ***only*** **in the** ***RES sector*** **(1st focus group)**
- ***Scenario 4***: ***OQS responses*** **from** ***engineers*** **(2nd focus group)**
- ***Scenario 5***: ***OQS responses only*** **from** ***islands residents*** **(3rd focus group)**

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Research Seminar, October 26-27, 2022

OWF Site Selection in Greece incorporating Public Participation (application example): Sensitivity Analysis *(2)*

Ranking **of the** ***13 EMAs for the 5 different scenarios***

Ranking	EMA (preference percentage)				
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
1	EMA11 (12.2%)	EMA11 (12.2%)	EMA11 (12.2%)	EMA11 (12.2%)	EMA10 (12.1%) *
2	EMA3 (11.3%)	EMA10 (11.6%) *	EMA3 (11.3%)	EMA3 (11.2%)	EMA11 (11.3%) *
3	EMA10 (11.1%)	EMA3 (11.5%) *	EMA10 (11.1%)	EMA10 (11.1%)	EMA3 (11.0%) *
4	EMA4 (8.8%)	EMA4 (8.9%)	EMA4 (8.8%)	EMA4 (8.8%)	EMA13 (8.8%) *
5	EMA1 (8.7%)	EMA1 (8.5%)	EMA1 (8.7%)	EMA1 (8.7%)	EMA1 (8.5%)
6	EMA13 (7.6%)	EMA13 (7.3%)	EMA13 (7.5%)	EMA13 (7.5%)	EMA12 (8.3%) *
7	EMA5 (7.5%)	EMA5 (7.2%)	EMA5 (7.4%)	EMA5 (7.4%)	EMA4 (8.3%) *
8	EMA12 (7.1%)	EMA12 (6.8%)	EMA12 (7.0%)	EMA12 (7.1%)	EMA5 (7.3%) *
9	EMA9 (6.3%)	EMA9 (6.4%)	EMA9 (6.3%)	EMA9 (6.3%)	EMA9 (5.8%)
10	EMA7 (5.8%)	EMA7 (5.8%)	EMA7 (5.7%)	EMA7 (5.7%)	EMA6 (5.6%) *
11	EMA6 (5.7%)	EMA6 (5.7%)	EMA6 (5.6%)	EMA6 (5.6%)	EMA7 (5.3%) *
12	EMA8 (4.7%)	EMA8 (4.7%)	EMA8 (4.7%)	EMA8 (4.7%)	EMA8 (4.3%)
13	EMA2 (3.8%)	EMA2 (3.7%)	EMA2 (3.8%)	EMA2 (3.8%)	EMA2 (3.7%)

* Different ranking compared to Scenario 1.

- ✓ ***Scenarios 3~4***: ***No difference*** **in the raking compared to** ***baseline scenario***
- ✓ ***Scenario 2***: ***A small change*** **compared to** ***Scenario 1***
- ✓ ***Scenario 5***: ***Differences*** **compared to the** ***baseline scenario***

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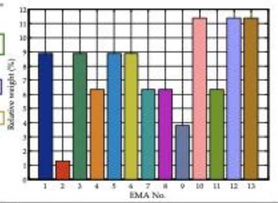
OWF Site Selection in Greece incorporating Public Participation (application example): Sensitivity Analysis *(3)*

Ranking **of the** ***13 EMAs for the 5 different scenarios***

EMA (preference percentage)

Ranking	Scenario 1	Scenario 5
1	EMA11 (12.2%)	EMA10 (12.1%) *
2	EMA3 (11.3%)	EMA11 (11.3%) *
3	EMA10 (11.1%)	EMA3 (11.0%) *
4	EMA4 (8.8%)	EMA13 (8.8%) *
5	EMA1 (8.7%)	EMA1 (8.5%)
6	EMA13 (7.6%)	EMA12 (8.3%) *
7	EMA5 (7.5%)	EMA4 (8.3%) *
8	EMA12 (7.1%)	EMA5 (7.3%) *
9	EMA9 (6.3%)	EMA9 (5.8%)
10	EMA7 (5.8%)	EMA6 (5.6%) *
11	EMA6 (5.7%)	EMA7 (5.3%) *
12	EMA8 (4.7%)	EMA8 (4.3%)
13	EMA2 (3.8%)	EMA2 (3.7%)



* Different ranking compared to Scenario 1.

✓ ***EMA10***: ***1st place*** **(one of the most socially accepted areas)**
✓ ***EMAs 12 and 13*** **:** ***Higher positions*** **(two of the most socially accepted areas)**

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Conclusions

• ***RES site selection***: ***Complex***, ***multidimensional decision making process*** **(joint assessment/management of** ***conflicting siting criteria*** **related to** ***technical***, ***economic***, ***environmental, legal*** **and** ***socio-political factors*****)**

• ***MCDA methods*** **can be** ***efficiently combined*** **with** ***GIS*** **to** ***tackle RES site selection problems***

• ***Good*** **&** ***sufficient spatial data*** **are** ***required***

• ***Active public*** **and/or** ***stakeholders engagement*** **within the** ***relevant site-selection process*** **may be** ***important*** **(the** ***size*** **of the** ***sample*** **is** ***crucial*****!!!)**

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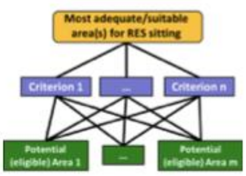
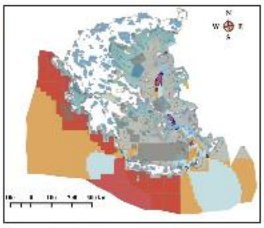
PEARLS EMPOWERING LANDSCAPES
H2020 – MSCA – RISE – 2017 – 778039

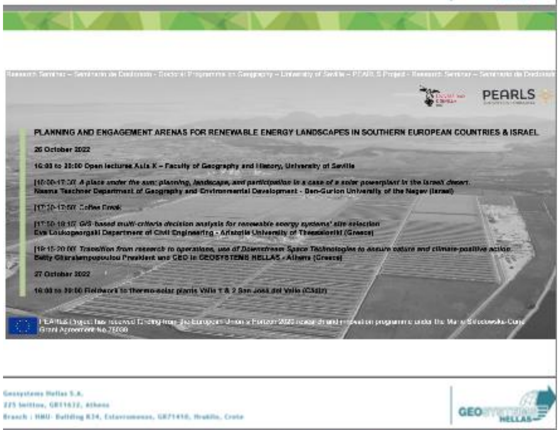
Research Seminar, October 26-27, 2022

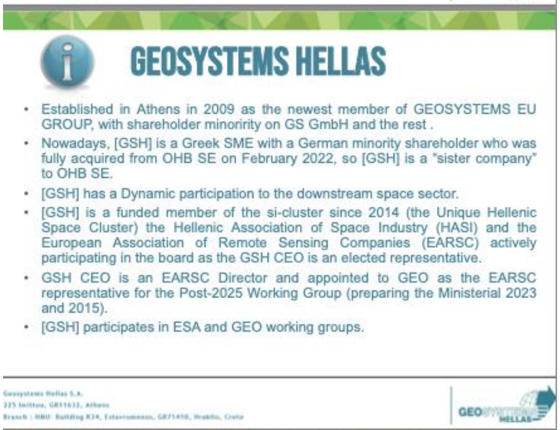
Thank you very much for your attention





Transition from research to operations, use of downstream space technologies to ensure nature and climate-positive action, by Betty Charalampopoulou





The implementation of the "New space economy"

- **resilience**
  - ✓Near real time monitoring by Earth Observation technologies
  - ✓Definition of risks (risks & hazards)
  - ✓Earth observation and Decision Systems
  - ✓Smart cities & security / Emerging Technologies and Blockchain
  - ✓Borders monitoring and EO contribution to DSS
- **adaptation**
  - ✓Proposals and design
  - ✓Utilities
  - ✓Culture Heritage
  - ✓Biodiversity
- **sustainable development**
  - ✓Change of urban zone
  - ✓Design of green structures in the city
  - ✓NBS & blue and green growth
  - ✓Citizen health and quality of life
  - ✓GIS / WebGIS

- ❖ High-level applications of remote sensing and photogrammetry, in the space sector
- ❖ Software solutions for on-board and on-site atmospheric correction, cloud cover control and generation of high precision cloud mask
- ❖ Management techniques for big data analysis, machine learning techniques (Big Data Analysis, Data Fusion, ML/DL), - System & Software design and development
- ❖ Airborne Lidar 3D monitoring techniques – development of detectable traces methodology
- ❖ Spatial analysis and GIS / WebGIS applications
- ❖ Geospatial intelligence (GEOINT) and data analytics
- ❖ Smart cities and Security – Earth Observation and Blockchain solutions

Recent & Current collaborations on:

- Earth Observation (EO)
- NBS & Blue/Green growth
- Lidar point cloud processing
- Monitoring Cultural Heritage
- Monitoring hazards & Decision Support Systems & Early Warning Systems
- EO application for security

HORIZON 2020/EUROPE
National R&D projects
National Projects Service Delivery

Earth observation based services for renewable energies (solar, wind, hydro-energy, biomass, geothermal and tidal energy)

The space industry, and related applications and tools, gives rise to a significant and innovative approach to clean energy generation; it is enough to think that starting from satellite missions, providing more and more accurate weather information from Meteo satellites helping the choice of the installation areas and on wind speed and sun coverage.

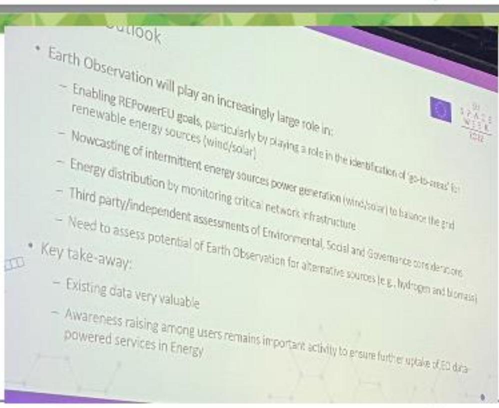
Macro level climate changes are impacting potential the renewable energies installations and/or new planned installations.

Large role of EO on biodiversity impact assessment for new sites.

EO satellites could be useful in the pre-feasibility phase to discriminate the type of installation that is not efficient for the selected location. We are able to map every area of the globe pipelines and power lines.

Space systems can measure the emissions, the wind turbine system is much more efficient than the photovoltaics in terms of financial indicators as well as the annual emission reduction of greenhouse gases.

Proven potential to accelerate businesses and carbon neutral ambitions of large energy companies.

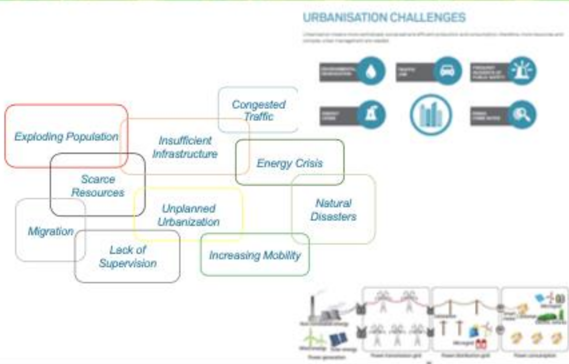


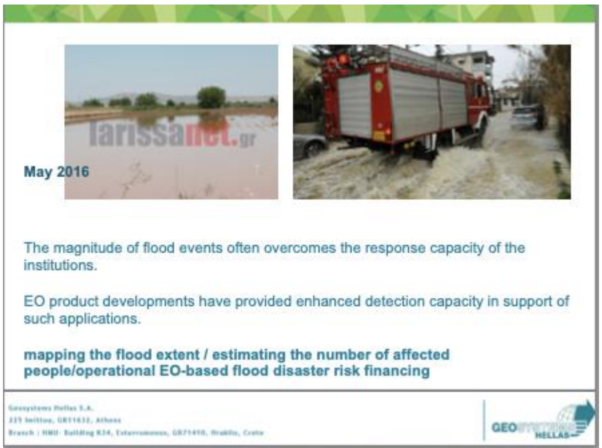
A French start-up has developed a green process to up-cycle raw materials from solar panels. ROSI just won the EU's new Industry of the Future Award…promises to enhance Europe's strategic autonomy by extending the domestic availability of valuable raw materials for industries including solar, electronics and batteries.

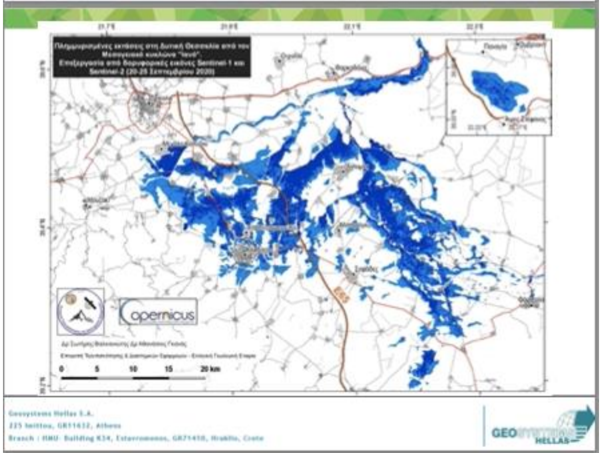
In reducing industrial waste, the project also helps the European economy to become more sustainable, or "circular".

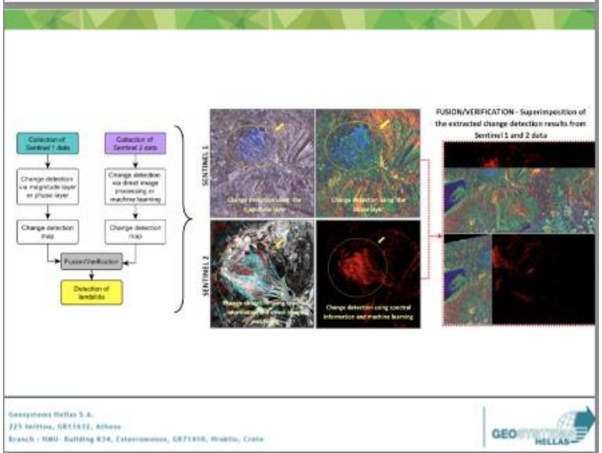
French tech start-up wins EU's new Industry of the Future Award with raw-materials prowess | Research and Innovation (europa.eu)

Recycling silicon from solar panels advances Europe's green goals as well as creating jobs and harnessing scarce resources.

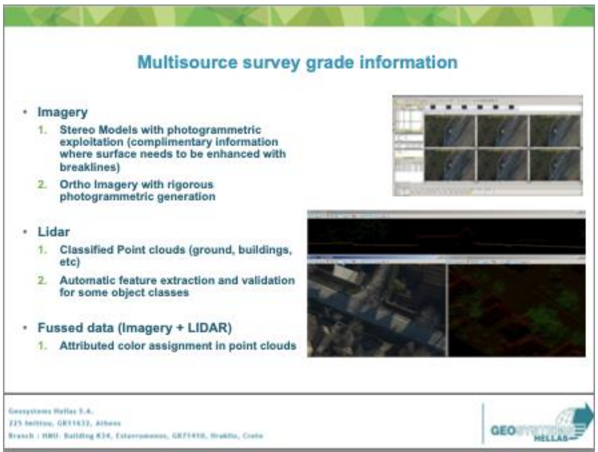



May 2016
The magnitude of flood events often overcomes the response capacity of the institutions.
EO product developments have provided enhanced detection capacity in support of such applications.
mapping the flood extent / estimating the number of affected people/operational EO-based flood disaster risk financing


opernicus

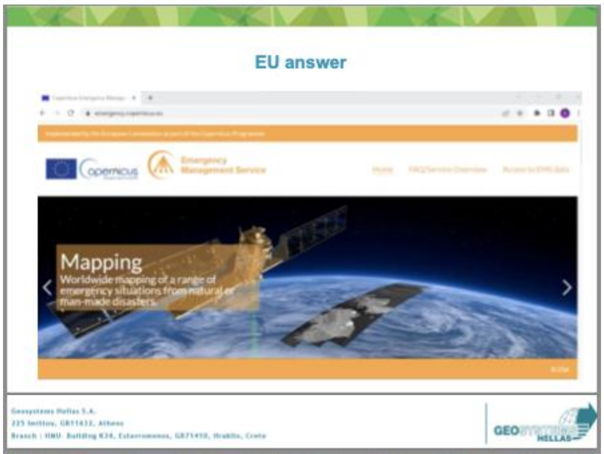

FUSION/VERIFICATION - Superimposition of the extracted change detection results from Sentinel 1 and 2 data


E65, October 2020

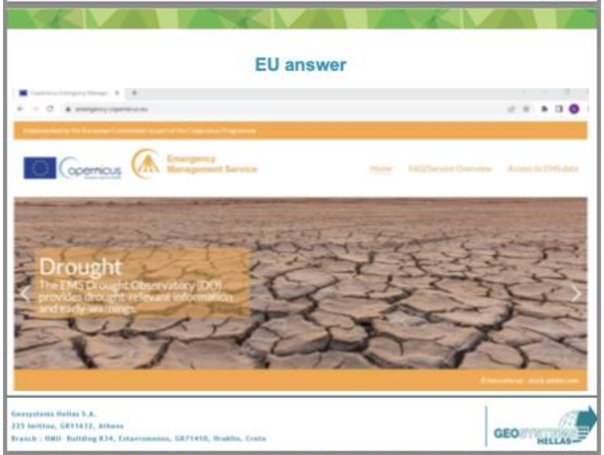

Multisource survey grade information
• Imagery
1. Stereo Models with photogrammetric exploitation (complimentary information where surface needs to be enhanced with breaklines)
2. Ortho Imagery with rigorous photogrammetric generation
• Lidar
1. Classified Point clouds (ground, buildings, etc)
2. Automatic feature extraction and validation for some object classes
• Fussed data (Imagery + LIDAR)
1. Attributed color assignment in point clouds

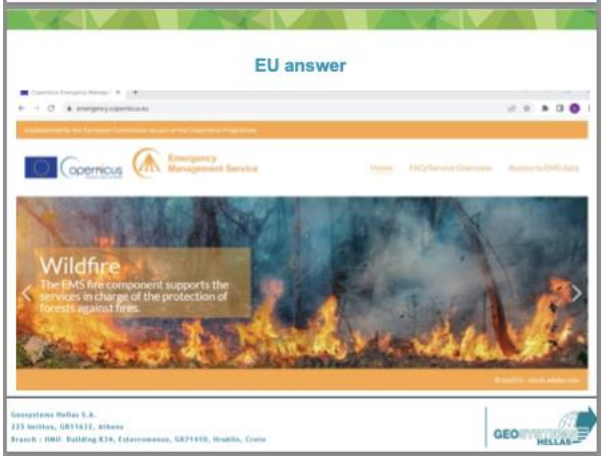

• Surface generated for all area study.
• Surface had selected critical ground class from Lidar along with critical breaklines

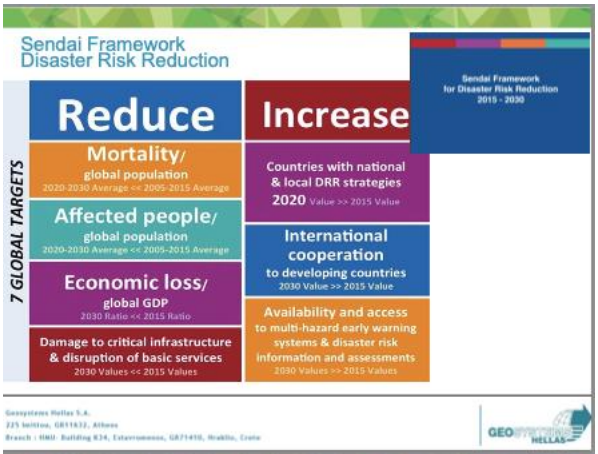

Classification Methods


EU answer
Emergency Management Service
Mapping
Worldwide mapping of a range of emergency situations from natural or man-made disasters.


EU answer
Emergency Management Service
Floods
The EMS flood component provides flood-relevant forecasting and monitoring information.


EU answer
Emergency Management Service
Drought
The EMS Drought Observatory (EDO) provides drought-relevant information and early warnings.


EU answer
Emergency Management Service
Wildfire
The EMS fire component supports the services in charge of the protection of forests against fires.


Sendai Framework
Disaster Risk Reduction
Sendai Framework
for Disaster Risk Reduction
2015 - 2030
7 GLOBAL TARGETS
Reduce
Mortality/
global population
2020-2030 Average << 2005-2015 Average
Affected people/
global population
2020-2030 Average << 2005-2015 Average
Economic loss/
global GDP
2030 Ratio << 2015 Ratio
Damage to critical infrastructure
& disruption of basic services
2030 Values << 2015 Values
Increase
Countries with national
& local DRR strategies
2020 Value >> 2015 Value
International
cooperation
to developing countries
2030 Value >> 2015 Value
Availability and access
to multi-hazard early warning
systems & disaster risk
information and assessments
2030 Values >> 2015 Values
GEOSYSTEMS HELLAS


Conclusion
? Future
Thank You
mail@geosystems-hellas.gr
GEOSYSTEMS HELLAS

IV. Networking Event

The PEARL*S* project aims reinforcing participant networks within Mediterranean countries as a way of renewable energy landscapes to be theorized, detected, addressed, and provide crucial support for the Pan-European Energy Challenge. By establishing international, intersectoral and multidisciplinary collaboration the project is building a nexus of a five-country holistic pool of universities and research centers in close cooperation with non-academic sectors. Although the initial idea to organize a Research Seminar after the second half of the project intended to disseminate research project results between PhD students as secondments, after the coronavirus pandemic and international political circumstances the idea has been reformulated. And the Research Seminar has been also considering as a challenge to project implementation, opening to all participants from academic and non-academic sectors to share the consortium's internal network activities.

Project implementation uncertainly due to the spread of coronavirus needs some actions to avoid virtual means of communication. All Work Packages has been and could being affected by this risk because they include secondments, network activities, tasks, and deliverables. First of them cannot be done under remote modes so a set of actions to exchange information, knowledge and innovation must no avoid social events in presential mode. This Networking Event has consisted of a two-hour session aimed at reinforcing communication between the secondments that had travelled to Seville beforehand and those who came expressly to participate in the results of the research seminar. In this way, personal contacts between all of them has been strengthened, helping to bring together perspectives and ways of dealing with future secondments in an atmosphere of collaboration and understanding. At the same time, it has served to encourage those project participants who have not yet implemented secondments to do so by making them understand the map of destinations, the panorama of options for realization and to make sense of the advantages provided by the exchanges.

V. Field work on local case Study

Valle 1 and Valle 2

Location: San José del Valle, Cádiz
Owner: Torresol Engery

Start: 2012

Power: 50 MW each

Electricity generation per year: 160GWh

The Valle 1 and Valle 2 solar thermal plants, in commercial operation since January 2012, arein San José del Valle (Cádiz). They are twin 50 MW adjoining plants1 owned by Torresol Energy. Both are developed with parabolic trough technology and have a molten salt storagesystem that allows them to continue producing electricity for 7.5 hours without sun,2 i.e. at night or in cloudy weather.

Construction of Valle 1 and Valle 2 began in December 2009 and was completed in December2011. Around 4,500 workers put in more than 2,700,000 hours of work during the two yearsof construction and until the plants, which are now connected to the Spanish national grid, were commissioned. Each of the 50 MWe plants can supply 160 GWh of clean and safe energyper year to 40,000 households. Together they reduce CO2 emissions by more than 90,000 tones per year. Thanks to molten salt storage, which allows the plants to continue producingelectricity in the absence of solar radiation, this clean source also becomes manageable, as itcan supply the grid according to demand.

Valle 1 and Valle 2 use SENER trough parabolic trough technology, which concentrates solarradiation onto a central collector tube through which thermal oil circulates. In addition, theyare equipped with a high-precision optical sensor that tracks the sun from east to west. The hot oil is used to vaporize water which, through expansion in a steam turbine, drives an electric generator that injects the energy into the grid.

Torresol Energy promotes the technological development, construction, operation, and maintenance of large concentrated solar power plants around the world. With the start-up of Valle 1 and Valle 2, the company has already developed three projects, including Gemasolar, which began commercial operation in May 2011.

https://www.energy.sener/project/valle-1-and-valle-2-plant

SENER

Power, Oil & Gas

Valle 1 and Valle 2 parabolic through plants

Valle 1 and Valle 2 parabolic trough plants, San José del Valle, Cádiz, Spain.

Valle 1 and Valle 2 are two adjacent 50 MW plants of electrical energy generation with similar characteristics located in San José del Valle (Cadiz, Spain).

The technology of these two twin plants is the parabolic trough collectors. Each of them consist of a solar field of 510,000 m² of SENERtrough® kind collectors, previously developed and qualifi ed by SENER. These collectors count on a high accuracy optical sensor to follow the sun from East to West to accumulate, this way, the maximum solar radiation.

More than 3,500 h annual production per plant

95,000 t CO_2 emission savings per year

80,000 homes receive this clean and safe power

The net power production for each of the Valle 1 and Valle 2 plants is 160 GWh/year. Thanks to their respective thermal storage systems, with 7,5 hours capacity, both plants will provide energy without fluctuation or interruptions, contributing to the power supply stability for more than 3,500 hours per plant/year, saving emisions of 95,000 t of CO_2 per year. 80,000 homes receive this clean and safe power.

SENER acted as project manager and provided 100% of the technology and engineering for both plants. Valle 1 and Valle 2 were built in parallel, with the logistics this implied: processing various types of supplies (purchasing, manufacturing, inspection, authorization of shipments to the site, transportation, receiving, and on-site storage), overseeing multiple contractors, quality control of the execution and, above all, planning and supervising construction as it progresses. This type of parallel construction has made Valle 1 and Valle 2 a milestone in the solar power industry.

Project data:

- Main characteristics: Parabolic trough and molten salt storage.
- Total mirror surface: 2x510,000 m².
- Number of SCA/loops: 2x624/156 SENERtrough®.
- Field surface area: 2x198 Ha.
- Nominal solar field thermal output: 2x262 MWt.
- Thermal storage capacity: 2x1,010 MWhth (7.5h).
- Turbine capacity: 2x50 MWe.
- Thermal cycle efficiency: 38%.
- Annual normal direct radiation: 2,057 KWh/m²
- Electricity delivery to 80,000 household.
- Around 95,00 tons/year of CO_2 emissions saved.
- Contract type: EPC.
- Scope: Basic Engineering, Detail Engineering Construction, Commisioning and Start-Up.
- Partners: ACS - COBRA.

Client: Torresol Energy
Start date: 2009
Ending date: 2011

dep.energia@sener.es - http://www.poweroilandgas.sener

VI. References

Romov, E.; Teschner, N. A Place under the Sun: Planning, Landscape and Participation in a Case of a Solar Powerplant in the Israeli Desert. *Sustainability* 2022, 14, 7666. https://doi.org/10.3390/su14137666

Spyridonidou, S.; Sismani, G.; Loukogeorgaki, E.; Vagiona, D.G.; Ulanovsky, H.; Madar, D. Sustainable Spatial Energy Planning of Large-Scale Wind and PV Farms in Israel: A Collaborative and Participatory Planning Approach. *Energies* 2021, 14, 551. https://doi.org/10.3390/en14030551

VII. PEARLS Consortium

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4		**ICSUL** Avda Prof Anibal de Bettencourt 9, Lisboa 1600 189, Portugal	Contact: Ana Delicado
5		**ENERCOUTIM** Centro de Artes e Oficios, Rua Das Tinas 1 esq, Alcoutim 8970 064, Portugal	Contact: Marc Rechtel
6		**COOPERNICO** Praca Duque de Terceira 24 4 Andar 24 Lisboa 1200 161 Portugal	Contact: Ana Rita Antunes
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