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Theories of Change and Impact Pathways

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Horizontal Integration and Priorities for a Future Crisis Management Concept

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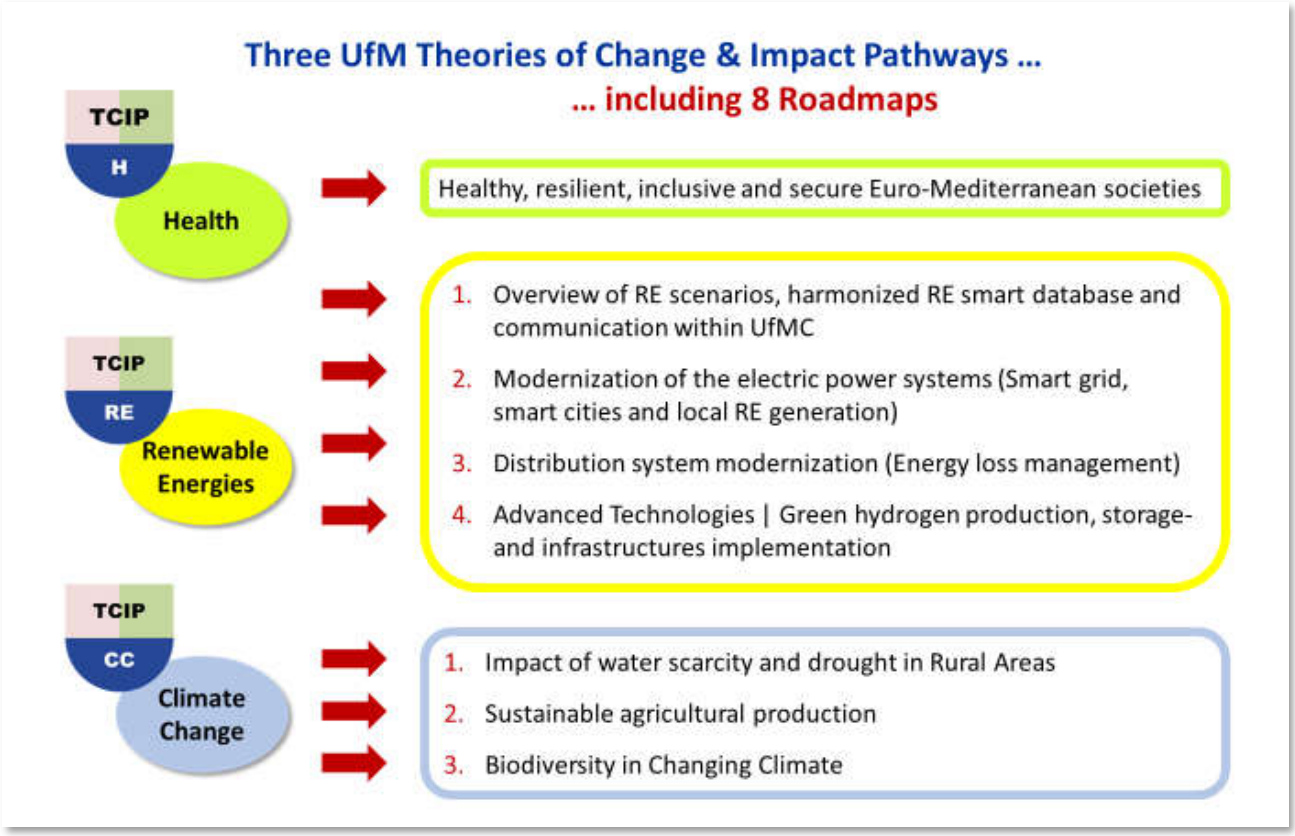

Executive Summary

The aim of this document is to create a common reference point for the UfM member states for the future research and innovation and capacity building activities in the three UfM priority areas Health, Renewable Energies and Climate Change. The Theories of Change and Impact Pathways (TCIP) instrument is the basis for this and consists of two elements:

1. Situation Analysis

First there is a situation analysis which informs about the current situation in the respective UfM priority areas in the Mediterranean region. After a SWOT (Strength, Weaknesses, Opportunities, Threats) Analysis, one can find a brief introduction into the situation regarding existing problems, their causes and the underlying knowledge and capacity related causes, as well as a brief context analysis, which includes a stakeholder analysis. Further details are given in the last chapter.

2. Roadmap (S)

Roadmap Content

1. Specific challenges
2. SDG reference
3. Research and Innovation Agenda and Impact Pathways
4. Capacity Building Agenda and Impact Pathways
5. Relation of the roadmap to the other priority areas

The roadmaps and impact pathways have been arranged in a hierarchical order, so that the one with the highest priority holds the number '1' and the others follow a descending hierarchy in their numbering and in the document. The Theory of Change and Impact Pathway for the health sector includes one roadmap.

To exploit the full potential of the TCIPs, a Monitoring, Evaluation and Learning (MEL) concept and framework should be developed together with actors, stakeholders and funding institutions. It is suggested to consider the implementation process of the TCIP and the application of a MEL approach

up to a final impact analysis, in a circular cooperation model. After one cycle, the TCIPs will form the basis for a reflection and a learning process which might then lead to the development of a new TCIP in a new cooperation cycle.

The document has been declined into three different TCIPs, including different roadmaps starting from the awareness of the diversified core constraints of Euro-Mediterranean Countries, the strategic activities that must be supported for promoting Research and Innovation (R&I) in each of the three areas that have been identified as strategic: Health, Renewable Energies and Climate Change. One aim is of achieving a long-term capacity development for the region, with significant social impacts. Another aim is to improve existing and where necessary to establish the coordination infrastructure for the UfM R&I and capacity building cooperation.

From the SWOT analysis, and common to all three priority areas the success of EU-Med R&I collaboration and impact on the region is seen as a strength. As weakness it is seen that the multiplicity of actors and initiatives in the region leads to the fragmentation of efforts and to limited synergies between them, with a risk of redundancy or unbalanced allocation of resources. The meta-governance of the overall R&I programmes and initiatives is almost inexistant. The inexorable deleterious effect of climate change is a major threat in all three areas.

Climate Change at the rate estimated now carries major uncertainties and risks to the well-being of people in the Mediterranean region. It should be recognized as a crucial force for the socio-economics of societies living in the region. The negative impact is felt already in food security, water scarcity and biodiversity. Tackling of these problems is best done via regional long-term cooperation in research, innovation and capacity building.

In the last chapter 'Horizontal Integration & Priorities for a Future Crisis Management Concept' a matrix shows the linkages between the three UfM priority areas as well as 12 priority areas for R&I in the UfM region for a future crisis management concept, which are:

1. Impact of Water Scarcity and Drought in Rural Areas
2. Sustainable Agricultural Production
3. Biodiversity in Changing Climate
4. Improving the health emergency preparedness of UfMC
5. Establishing sustainable and resilient health systems able to answer the needs of the populations, in particular the most vulnerable
6. Overview and modelling of RE scenarios, harmonized RE smart database and communication within UfMC
7. Modernization of the electric power systems (Smart Grid, Smart Cities and local RE generation)
8. Distribution system modernization (Energy Loss Management)
9. Advanced Technologies, Green Hydrogen Production, Storage and Infrastructures implementation
10. Energy -Stability towards stability in Health Systems, Agriculture and Food System and resilience in the context of Climate Change
11. General reliable data-collection, as well as - sharing and -communication for decision making
12. Qualitative data-collection about local (potential) crisis situations and gender specific issues for local interventions towards capacities

These 12 main drivers, developed and planned in a strong mutual interconnection within the three Expert Groups, (Health, Renewable Energies and Climate Change), are embedded into the three

following Recommendations, developed in detail the "Horizontal Integration & Priorities for a Future Crisis Management Concept" section:

Policy Recommendation 1 | Significantly increase the exchange and circulation of knowledge and information in the three priority areas together with the implementation of platforms for facilitating the availability and communication of timely and reliable data, also accessible to stakeholders. The intention is to build up a circular communication platform and mechanism that could engage all the stakeholders by promoting a positive and participative interaction. This recommendation reflects the need for initiatives to fill the existing gaps within Euro-Mediterranean Countries on Health/Renewable Energies/Climate Change matters, due to a different maturity of both economy, technology and infrastructures. This goal is considered necessary to stimulate a joint approach to face a Green Energy transition in a global research approach with expected impact on food and nutrition security health and climate change fight as well. This recommendation could also provide opportunities to address vulnerable populations and to increase employment rates under the overarching values of social justice, solidarity and youth needs, by enhancing sustainability in strategic sectors, such as agriculture production and food and health systems in general.

Policy Recommendation 2 | Promote demonstration TRANSDICIPLINARY projects on sustainable development in the Euro-Mediterranean Region. This recommendation reflects the need for initiatives to provide tools for guiding the path towards Research and Innovation in a cooperative approach. This could be achieved by supporting joint R&I and capacity building programmes finalized to build Renewable Energies demonstration pilot plants, infrastructures, also in small-scale, with reference to smart city/village/ grid models and based also on innovative/advanced technologies. Under this approach, valuable connections with the goal of building up resilient health infrastructures and with the goal of stopping climate change are expected.

Policy Recommendation 3 | Promote technology cooperation. This recommendation reflects the need for establishing a network between Research and Higher Education Institutions, National Authorities/Observatories, private companies dedicated to the Renewable Energies, Health and Climate Change/Environmental sectors – in a multilateral approach with Mediterranean Countries - to develop innovative interconnected ecosystems with important repercussion on R&I and on sustainable development of the whole region. In this context, the Southern and Eastern Mediterranean Countries could be at the European core testbed for Renewable Energy tech development and implementation, also for developing carbon-removal strategy and incentives' policies. In order to positively stimulate a collaborative eco-system, scientists from South-East-Mediterranean Region should be allowed to participate in equal conditions as European centres even if their countries do not contribute financially to EU funds.

Suggested Actions

1. Establish a network of greenhouse gases stations for a decarbonization and RE strategy
2. Establish a shared energy statistics database integrated with tools for monitoring energy indicators
3. Establish joint long-term research centers addressing health, renewable energies, climate change
4. Establish a Mediterranean climate observatory and an index for climate change and sustainability
5. Establish a regional center for epidemic preparedness and response

6. Marie Curie Actions exclusively for North African young scientists
7. Establish a North Africa-EU RDI programme in the priority areas

To achieve these goals, operative research infrastructures/centers/platforms/frameworks have to be established with the requirement of being inclusive with respect to the issues of all the 3 priority areas (Health, Renewable Energies and Climate Change). The operative structure, that could also start from already existing partnership platforms in the frame of Euro-Mediterranean cooperation, might envisage different sub-center with specific competencies, which will have to be coordinated in a collaboration infrastructure to avoid fragmentation, which might also be co-supported by each member state. The aim is to support joint programs able to empower each country, or group of countries, towards a renewed vision for socio-economic development in Euro-Mediterranean Region.

Draft Theory of Change and Impact Pathway

Technical Experts' Group on
Research and Innovation

Situation Analysis

1. SWOT
2. Problems | Causes
3. Context & Stakeholder Analysis
4. Further Details

Roadmap and Impact Pathway

1. SWOT

The present swot analysis has a wide scope (R&I context of the Euro-Med region collaboration in the priority area, governance, technological innovation, social, cultural and economic context). This would allow to cover various aspects of the situation analysis with a system approach.

STRENGTH

- Success of several international cooperation activities at the Euro-Mediterranean levels between (health) centres of excellence, with a wide type of activities (RIA, CA, Capacity building etc.)
- Strong enthusiasm and willingness of several research actors and stakeholders (researchers, CSO activists, decision makers) from both shores of Mediterranean to collaborate and conduct common R&I activities for the benefit of Euro-Med populations.
- Mobility programs for Euro-Mediterranean Researchers in particular young researchers (Erasmus plus, MSCA) allowed to develop highly skilled human resources able to tackle regional specific health challenges, build long lasting relationships between the scientific community in the region.
- Improvement of health indicators and achievements in the health sector in the region: better health infrastructure, trained health professionals, decrease or eradication of some infectious diseases, better health outcomes for NCDs. Part of this improvement have been possible thanks to know-how and technology transfer facilitated by Euro-Mediterranean R&I collaboration.
- The Euro-Mediterranean populations have particular genetic structure with a variety of admixed as well as isolated populations.This provides a valuable opportunity for epidemiological observational studies as important tools for longer-term impacts on public health.
- The Euro-Mediterranean populations share common rich cultural heritage in particular nutritional habits (Mediterranean diet) that has a great potential for health benefit. This offers opportunities for exchange of knowledge and development of products and services to improve health of Mediterranean populations.

OPPORTUNITIES

- The current health crisis (counter intuitively) and coronavirus SARS COV2 pandemics provides a great opportunity to improve and to make enormous strides towards more collaborative R&I in the region that would lead to better health of populations.
- Digitalization (and various ICT tools, including social media) and open science provide access to a wealth of data and helps to overcome several barriers between the various actors and stakeholders in the (health) research community (geographic, cultural, etc.) enabling more training, vocational and lifelong learning of the health professionals also through digital tools. E-twinning provides several opportunities to train young researchers, to share experiences in a cost effective and efficient way and to transform the acquired knowledge into innovative services and products.
- Availability of tools/platforms for Responsible R&I narrow the gap between the various stakeholders and provide the path to find affordable solutions to social needs.
- Development of new technologies, in particular genomics, nanotechnology, IT etc. This helps to improve our understanding of disease aetiologies, provide new diagnosis tools that help early detection of diseases and consequently better health outcomes for Euro-Mediterranean populations.
- There are still several unexploited niches for health R&I in particular in the investigation of rare genetic diseases as models for common chronic diseases, combination of new technologies (digitalization of clinical trials, use of generic drugs, genomics etc.)
- Interplay between the three majors thematic (health, renewable energies and climate change) allows trans-disciplinary, transborder collaborative initiatives thus maximizing the impact beyond that of each individual initiative.

WEAKNESS

- Economic growth has been to some extent at the expense of health.
- Despite scientific evidence, the impact of climate change on health has been insufficiently considered as a priority.
- Low involvement of the communities and Civil Society Organizations (CSO) in (health) research, leading to poor uptake of research results and inefficient health interventions.
- Poor quality of scientific mediation/communication to reach out the various communities, including researchers from other disciplines, limits policy uptake and translation of research results into effective interventions and loses the chance to enhance scientific, environmental and sustainability literacy of the citizens.
- Low capacity of the region to attract, retain and invest in the highly skilled and educated young researchers compared to other parts of the world.
- Disparities between Euro-Mediterranean countries in (health) research capacities, governance, technology transfer and innovation management policies and regulatory aspects (e.g., ethics, data sharing and protection etc.). Health inequities persist in the region (various causes of vulnerability: gender, age, socio-economic, health conditions, displacement).
- Health inequities are increasing dramatically with the current pandemic. Countries of both shores of Mediterranean are unable to produce locally essential products to face the pandemic.
- (Consequently) Euro-Mediterranean Health Innovation policies need to be revised in collaboration with health industries among other stakeholders.
- The multiplicity of actors and initiatives in the region leads to the fragmentation of efforts and to limited synergies between them with a risk of redundancy or unbalanced allocation of resources. The meta-governance of the overall R&I programmes and initiatives is almost inexistant.

THREATS

- Considering economic and technical growth as the major drivers of (market oriented) R&I programs at the expense of other factors (in particular social factors).
- Limited preparedness of the health systems (including research actors) to face health crisis or other challenges (e.g., natural or other types of disasters).
- Persistence of the health crisis in particular the coronavirus SARS COV2 pandemic threatens the resilience of the health system even for the most developed ones.
- The waste production and management that was already threatening the environment and health of Euro-Mediterranean populations is worsened by the current pandemic with the related biological risks.
- Impact of climate change is increasing the burden of Infectious and non-infectious chronic diseases and is creating new vulnerability groups (migrants, people with heavy disabilities due to comorbidity).
- Inequities, if not considered and adequately addressed, are going to expend at a level that amplifies crisis and be itself a “natural” disaster leading to displacement of populations and intensifies migration.
- The absence of an adequate policy and regulatory framework in particular in the South-East Mediterranean Region will lead to poor management of the current and to come health crises. This urges new strategies and policies related to technology transfer and innovation management adapted to persisting crisis situation.
- Lack of trust of the communities towards research and health research professionals will lead to no compliance with preventive measures, and in some cases an increase in unethical behaviour.
- Brain drain and impoverishment of the HR capital in the region.
- The absence of a clearly stated inclusion of health research from the regional priorities and from the existing water-energy-food nexus leaves the regional agenda unfinished with unanticipated undesirable consequences.

2. Problems | Causes

A. What are the problem areas?

The health situation in the Mediterranean is changing rapidly, driven by socioeconomic development and the evolving demographic and epidemiological transitions. Fortunately, life expectancy in the Region has increased and several health indicators have improved. Despite these improvements, several challenges remain or are currently rising due to multiple factors (aging of the population, urbanization, climate change, increasing inequities, etc.). The current pandemic being an example and may be the beginning of the new type of health crisis that human populations, in particular in the Euro-Mediterranean region, have to face.

During the last two decades, establishing a common R&I agenda in the Euro-Mediterranean region has led to the setup of multiple international collaborative projects that have been successfully implemented. This is due to the high enthusiasm and willingness of various R&I actors in the region to tackle common challenges. Despite the numerous strengths and opportunities of the collaborative R&I, several weaknesses remain and threats have to be foreseen as red lights in the region in particular considering the alarming climate change in the region with the higher warming levels and associated risk that menace the Mediterranean basin and its populations (Giorgi 2006). The priority setting exercises conducted in the region shows that some problem areas are still remaining at the top of priorities in the region.

Indeed, emerging and re-emerging infectious diseases and non-communicable diseases have been identified as problem areas in the region for more than ten years. Several collaborative programs have addressed these topics. Nevertheless, the uptake of research results by the various stakeholders is not giving its full potential and several evidence-based and proven interventions are not implemented. In addition, due to the recent health crisis, health disparities have been accentuated in particular women and vulnerable populations' health. If we take into consideration the impact of the numerous social-economic and environmental changes, the region has to be prepared to face various crisis and potentially environmental or “social” disasters leading to populations’ displacement and intensifies migration.

Emerging and re-emerging infectious disease

The prevalence of hepatitis, brucellosis, typhoid, schistosomiasis and vaccine-preventable communicable diseases is much higher in the South-East Mediterranean Countries. For several years, researchers in the region from both shores of the Mediterranean warned about the risk of new emerging infectious diseases. The last outbreak demonstrated the deleterious impact of such communicable diseases that is exacerbated by comorbidities with non-communicable diseases. As an example, there is strong evidence that prevention of obesity and type 2 diabetes will reduce the risk of serious infectious diseases such as COVID-19 outcomes. Given the known impacts of all forms of malnutrition on the metabolic as well as the immune system, public health strategies to reduce micronutrient deficiencies and undernutrition remain of critical importance. With the dynamic and evolving situation in the region, there is a need to setup a strong and proactive regional epidemiological surveillance system/center and to improve the health emergency preparedness of Euro-Mediterranean Countries (EMC).

Non-communicable diseases (NCD)

NCDs, such as cardiovascular diseases, cancer, chronic respiratory diseases, and diabetes, are chronic diseases with slow progresses and lasting for a long time. In South-East Mediterranean Countries, 30% of adults living in urban area suffer from metabolic diseases (co-occurrence of obesity, diabetes, hypercholesterolemia and/or hypertension. NCD represent major causes of disability, ill-health, health-related retirement, and premature death in the EU, resulting in considerable social and economic costs. According to the Organization for Economic Co-operation and Development (OECD), every year in the EU, approximately 550,000 people of working age die prematurely from non-communicable diseases. As the leading cause of mortality in the EU, they account for most healthcare expenses, costing EU economies €115 billion, or 0.8% of GDP annually (https://ec.europa.eu/health/non_communicable_diseases/overview_en).

Pollution in South-East Mediterranean Countries is another serious cause for concern, as it related to a high burden of morbidity and mortality, in the general population at large and in particular, on vulnerable segments of society. To efficiently address the huge challenge of greening/blueing large cities in those countries will require an integrated approach stemming from the three main areas (climate change, renewable energies and health). In particular, climate characteristics of vast areas, make it impractical to implement some of the greening/cleaning air strategies effective in other areas (e.g. in northern Europe, as for a rainfall-limited seasonal budget). Other innovative greening strategies must be developed and adopted.

Protecting women and vulnerable populations' health

Women's health and well-being is important not only for women, but also for their families and society as a whole, because of their pivotal role, among others, as caregiver of the entire society. This has been again proven in the recent pandemic with an increased pressure and "duties" on women's shoulders during lockdown.

There is a need to consider gender equity from a different perspective by respecting socio-cultural diversity and by taking into consideration the role of each member of the family, in particular the vital role of women in the family and society. Despite constant interest in gender equity in the various Euro-Mediterranean programs, there are limited tangible actions that have been so far conducted to tackle gender issues in the region. This is also the case for other vulnerable populations: children and adolescents, in particular those affected by disabilities, as well as elderly, migrants. Indeed, health disparities persist in the region and are augmented, and the gap is expected to continue widening with the current health crisis with a general worsening in the socio-economic and health conditions.

These challenges have no geographic boundaries and figures are increasing. Prevention, early, appropriate diagnosis and treatment as well as global R&I partnership are needed to combat these diseases. The abovementioned problem areas are all shaped and sometimes exacerbated by climate change. Indeed, global warming caused by rising greenhouse gas (GHG) emissions will threaten mass populations through increased transmission of some infections, heat stress, food and water insecurity, increased deaths from more frequent and extreme climate events, threats to shelter and security, and through population migration.

Emphasis should be placed on improving health outcomes for marginalized and disadvantaged populations, primary health care-based approaches and regional public health capacity should be enhanced through partnership.

Individual countries differ widely in regard to the specific challenges faced and have different population health outcomes, health system performance and level of health expenditure. Crosscutting issues in health systems and increased intersectoral collaboration are needed to effectively impact on social determinants of health and to reduce health disparities and inequities.

Addressing complex societal challenges, such as the health of populations in a challenging context as exposed here, requires **transdisciplinary research (TDR)**. TDR involves the integration of knowledge from different science disciplines with the involvement of all actors and stakeholders of public and private sector stakeholders and citizens.

Based on all these elements the following subtopic should be considered as a holistic approach to tackle the variety of challenges faced in the region:

Healthy resilient, inclusive and secure Euro-Mediterranean societies

B. Which are the causes and the underlying knowledge- and capacity related causes?

Emerging and re-emerging diseases have several causes and are determined by many factors: climatic, food, genetic susceptibility, hygienic, socio-economic conditions etc. The transmission of diseases is caused by infectious agents - bacteria, viruses, protozoa, parasites - that pass from sick to the healthy or from an animal to man (zoonosis). Infectious diseases do not affect randomly, and often preventive treatments such as vaccines, or more careful hygiene and food behavior can help to combat them. Climate change, ecosystem disruption, urbanization, high density of populations in

addition to pollution impact on the populations and they become more susceptible or more prone to infections. There is a mutual impact between socio-economic conditions and health with poor conditions leading to poor health outcomes and vice versa. Natural and social disasters amplify populations' displacement and migration. The vicious circle continues as migration together with international travel contribute to rapid spread of infections.

Antimicrobial resistance, in particular in hospitals, challenges the control and spread of infections.

The recent outbreak has shown the insufficiency and/or inefficiency of scientific mediation & communication that conducted to low uptake of proven interventions (e.g. the challenge of social distancing during epidemics, acceptability of vaccination etc.). It also showed the unpreparedness of the health system and absence of public health strategies.

Several other capacity related causes could be identified

- Inability to induce change
- Ineffective governance and leadership
- Limited health and education programs for all the stakeholders (health, nutrition and food litteracy).
- Weak ethical, legal and regulatory framework in South-East Mediterranean Region in particular in relation to open science, data sharing and data governance in general (ethical litteracy).
- Misinformation, communication and scientific mediation (scientific literacy, capacity to involve citizens or other types of stakeholders, digital literacy and IT infrastructure)
- Very limited resources deployed to revert the R+D+I situation.
- Environmental and sustainability literacy is dramatically limited

Education has important social impacts on health. There are evidences that it impacts directly on mental and physical health. It has been also acknowledged that environmental literacy can provide a strong foundation for future environmental responsiveness, as well as help in the transition towards more sustainable societies (sustainability literacy) and healthy living (health literacy).

Environment and social situation can affect in a deeply way vulnerable and socially disadvantaged people, especially because they can be exposed to more harmful products or can experience an unhealthy lifestyle.

Limited commitment in the region, in particular from South-East Countries, to take the appropriate measures to use alternative energies and to lower the impact of climate change reflects also a limited understanding or awareness of their threats on health of populations. This shows again the limited preparedness of the region to face the various associated risks and crisis.

3. Context Analysis | Stakeholder analysis

The Euro-Mediterranean region nowadays has to cope with a complex situation and to face several challenges: health crisis, economic recession, lack of trust in decision makers, more health disparities etc.. Despite the complexity of the situation and thanks to the willingness of researchers from various centres of excellence from both shores of the Mediterranean, several collaborative projects have been conducted successfully in the region. Multiplicity of (excellent) initiatives not backed by a stronger political will nor by a support to synergize and maximize uptake of the research results, reduces importantly their potential impact.

NCDs are the world's biggest killers and a leading cause of death in the Region http://www.emro.who.int/entity/ncds/index.html, causing 1.7 million deaths every year.

http://www.emro.who.int/noncommunicable-diseases/publications/burden-of-noncommunicable-diseases-in-the-eastern-mediterranean-region.html

The leading cause of death in the Eastern Mediterranean region in 2013 was ischaemic heart disease (90·3 deaths per 100 000 people), which increased by 17·2% since 1990 (Mokded el al. 2016).

The prevalence of hepatitis, brucellosis, typhoid, schistosomiasis and vaccine-preventable communicable diseases is much higher in the South-East Mediterranean Countries; mainly due to poor hygiene and inefficiency of the health systems to provide viable health services in all areas, especially in remote and hard-to-reach areas. The outbreak of Hepatitis A among schoolchildren is an example of the inefficiency of the health system to provide proper hygiene in schools and public places.

The vulnerability created by disabilities and various types of diseases, be it communicable or non communicable, brings another burden on women as principal caregivers in the region in particular in South-East Mediterranean Countries due to unavailability or inaccessibility to adequate health care. The gender issues should consequently be considered from a different perspective. Health promotion of women not only answers to their specific needs (physiological or pathological aspects), but also contributes to the improvement of health status of the entire population and is a measure of the quality, effectiveness and equity of the health care system. In fact, women are health drivers of health promotion through lifestyle choice and at the same time they are caregivers of the care of their families, especially in the South-East Mediterranean Region they are considered as the "helping" member of the family, in particular when there is a disability, vulnerability and/or sickness in the family in which they are playing a major role.

The vulnerability due to health and socio-economic conditions and to various other factors is dramatically increased with the impact of climate change on the populations. A recent report by the Intergovernmental Panel on Climate Change (IPCC), amounting to nearly 3000 pages of detailed review and analysis of published research, also declares that the scientific uncertainties of global warming are essentially resolved. This report states that there is clear evidence for a 0.75°C rise in global temperatures and 22 cm rise in sea level during the twentieth century. Costello et al. 2011. The Mediterranean region has the highest rate of global warming compared to other regions in the world.

Despite these various challenges, there are still several R&I niches not yet exploited in the euro-mediterranean region, in particular using a trans-disciplinary participative approach. The genetic, environmental and socio-cultural diversity across the Euro-Med region has been recognized for decades as offering a unique opportunity for research to identify origins of diseases and new ways of fighting them.

With the recent technological development in particular in the field of genomics, nanotechnologies, Artificial Intelligence (AI) and health, the scenary of health research is being completely changed. Access to an impressive amount of data, Big Data, is an indispensable pre-requisite to any type of research. This needs not only adequate infrastructure, competencies and regulationsi but also the possibility to share important health and associated data across the frontiers (across disciplines and countries as well). In addition, considering genomic informed pathogen surveillance, building regional capacities in the region will help tackle challenges related to food safety (foodborne diseases) and increasing epidemic preparedness.

Several initiatives and alliances have been set in order to face the global challenges (Global Alliance for Chronic Disease GACD, International Common Disease Alliance (ICDA), Global Research Collaboration For Infectious Diseases Preparedness GloPID-R etc.). This raises several issues in particular the difficult equation between data sharing and data protection. The need for the adequate international framework in the region for open science in particular inr egard to data sharing was exacerbated during the current health crisis. The UNESCO initiative on open science in the world and in particular in the region (Arab world) raised the question on how to operationnalize Open Science in the region. The ability to access and combine several data can advance research, improve analysis and evaluation, inform program and policy development, increase capacity for public participation, enable transparency and improve accountability.

A related challenge can be traced back to the lack of specialists in Data Protection and DPOs, particularly because of the absence of proper training programmes on these important issues.

Several institutions in South-East Mediterranean Region have Institutional Review Board (IRB) that need a reinforcement in their capacities for the evaluation of research using new technologies in particular genomics, e-health related technologies and projects related to AI. In some cases the institutions have no IRB. The latter are needed to evaluate the new health science research and protect people, creating new capacity for health research and enhanced levels of trust, including bidirectional cultural education between academic researchers and policy members.

One of the biggest challenges remains the "ethical literacy" issue: people and professionals should be educated to recognize, understand and react to the new demands of society. It will be fundamental to trace targeted capacity building activities for all the health research actors and stakeholders (NGO, Health Professionals and young researchers, education institutions etc.) Digital literacy is also crucial, several families in the region have been forced to enter into the digital era because of the lockdown. Despite the beneficial effect, this also widenes the social inequities.

Stakeholders

Policy makers, Health workers and civil society organizations, and the strong involvement of national Ministries of Health, Schools, Food Industries, Regulatory bodies, NGOs, Educators, Hospitals, IGOs, Scientific Community and Nonscientific communities, Media

Health services, the quality of health care and the whole health system require good governance, good political choices for health, an informed and active stakeholder etc.

Changing the governance in the health system, it means to possibly respond to the present and future challenges facing the health system: infectious diseases outbreaks, pandemic, the increase of NCDs.

Reinforcing the health system by operating changes in the governance can bring prosperity and growth in different ways in the health sector as political effort to align the policies in a regional way, bringing new technologies, changing in patients' and professionals' view of their roles, readiness to manage crisis etc. to provide the system an equitable, sustainable, quality health care.

Working on governance (for example creating new forms of mandatory action or new regulatory mechanisms) means better quality in the standards of care, treatment choices, performance and other outcomes.

Building quality in health systems should become a prior mission that can have a positive economic impact, with less considerable cost implications for health systems.

4. Further Details

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List of global alliances to globally respond to the health challenges

https://www.gacd.org/

https://www.glopid-r.org/

https://www.icda.bio/

Examples of successful projects:

- Control of leishmaniasis, from bench to bedside and community GA Id: 642609 https://cordis.europa.eu/project/id/642609) LeishShield-MATI or other examples on leishmaniasis is one oft he examples need tob e added in the context
- H2020 project: GA ID: 776665 Edible Cities Network Integrating Edible City Solutions for social resilient and sustainably productive cities https://cordis.europa.eu/project/id/776665)
- Ingenious Science shops to promote Participatory Innovation, Research and Equity in Science. GA ID: 741677 https://cordis.europa.eu/project/id/741677)
- The Italian National Team for Infectious Diseases 'L. Spallanzani with the project EUNID (European Network for Infectious Diseases physicians) and EuroNHID (European Network for Highly Infectious Diseases)
- Several projects have been identified in relation to the various regional sub-priorities
- https://www.minplusproject.eu/progetto/ MIGRATION
- https://cisotra.eu/it/ MIGRATION
- https://climate-adapt.eea.europa.eu/knowledge/adaptation-information/research-projects/ramses SMART CITIES, GOVERNANCE
- www.mediterraneandietseminar.org FOOD
- https://www.interregeurope.eu/ithaca/ HEALTH
- https://echonorthernireland.co.uk/ HEALTH
- https://doctorshello.com/ HEALTH
- https://www.erasmus-fields.eu/?lang=en EDUCATION AND BIO
- http://lllplatform.eu/what-we-do/eu-projects/comorelp/ EDUCATIONAL
- https://farmingfirst.org/food-systems#home FOOD
- https://susfood-db-era.net/main/ FOOD
- https://www.scabec.it/progetti/md-net FOOD AND MEDITERRANEAN DIET
- https://camfed.org/our-impact/leading-climate-action/ FOOD AND CLIMATE
- https://climate-adapt.eea.europa.eu/knowledge/adaptation-information/research-projects/CASCADES CLIMATE AND GOVERNANCE
- https://climate-adapt.eea.europa.eu/knowledge/adaptation-information/research-projects/climsave CLIMATE
- http://mayors-adapt.eu/ CLIMATE

- Silvanus Project in Horizon2020 recently won by the Pegaso Online University that will collaborate with 50 universities from four continents and plans to provide a technological platform for ecologically sustainable forest management.

Roadmap and Impact Pathway

Towards healthy, resilient, inclusive and secure Euro-Mediterranean societies
(environmentally friendly / resilient health systems, renewable energies, climate change, smart cities, digitalization, open science, data, ethics, trans-disciplinary, inclusive, participative, build on other ongoing initiatives, equity)

1. Specific challenges

The health situation in the Mediterranean is changing rapidly, driven by socioeconomic development and the evolving demographic and epidemiological transitions. Fortunately, life expectancy in the Region has increased and several health indicators have improved. Despite these improvements, several challenges remain or are currently rising due to multiple factors (aging of the population, urbanization, climate change etc.). The current pandemic being an example of the type of health and consequently socio-economic crisis that the human populations, in particular Euro-Mediterranean's, have to face in the future. There are important disparities among countries in the region in their abilities to cope with and recover from health crises. This raises the major challenge of how could the R&I help to improve the health emergency preparedness of Euro-Mediterranean Countries (EMC) and to establish sustainable and resilient health systems able to answer the needs of the populations, in particular those in a situation of vulnerability due to gender, age, socio-economic or health conditions.

2. SDGs

This roadmap and its impact pathway are contributing to the following SDGs:

SDG	Comment
	Trans-national, trans-disciplinary participative health research and innovation will lead to improved health of populations. Prevention and improved care decrease the number of patients and lowers complications' risks thus diminishing the impact of diseases.
	The education divide needs to be bridged as it is highly related to health inequalities. Pathways should be by means of new incentives to better education standards and more investment of resources. Empowering people by lowering levels of illiteracy is mandatory to better health and life prospects. Links with SDG8. Research strength particularly in the South-East Mediterranean Countries needs to be urgently enhanced.

SDG	Comment
  	Wellbeing is a precondition for education, work, life etc. Healthier populations are more productive. The exploitation of research results will allow the creation of new job profiles and new job opportunities thus stimulating economic growth. Healthier populations lead to wealthier societies, less prone to conflicts due to inequalities.
	Taking into account gender in medicine, irrespective of the type of gender, will help more personalized approaches, and consequently better outcome of health interventions.
	Access to safe and clean water should be prioritised at all times and segments of society (including use of renewable energies). It improves sanitation standards and lowers waterborne + foodborne + vectorborne diseases.
 	Being more equitable and inclusive impacts by itself directly and indirectly on the health of vulnerable populations and brings social justice. There is a mutual impact between health and diminishing inequalities, people with disabilities, if they have job opportunities will have better health and vice versa.
	Urban development and greening of cities has a direct effect on human health, with pollution mitigation being central to lowering NCD (cardiovascular, respiratory…). The tight link between climate change and pollution has a large burden of disease in populated cities.
	Action on climate adaptation has a direct revenue in terms of DALYs and mortality and largely on human health, both for NCD and infectious diseases across the two shores of the Mediterranean region. Some countries, particularly in the South-East shore are very well suited to maximize investments on renewable energies, helping on climate mitigation and offering opportunities for green economy and development.
	The collaboration of researchers across multiple disciplines and partnership between various actors will lead to sustainable innovative and efficient products and services to answer the needs of the Euro-Mediterranean populations thus reaching the goals. The Mediterranean region NEEDS to (CAPITALIZE) Conduct common Euro (Mediterranean) actions to face the challenges on Health, Climate change and Environment and Renewable Energies.

3. Research & Innovation Agenda and Impact Pathways

Technological development and efficiency

(The specific topic and technological aspect of the research has to be investigated under components and system point of view. To which specific questions does the technological research respond to?)

#1 Establish an epidemic preparedness and response EPR Intelligence hub for rapid action coordination among Euro-Mediterranean countries (e.g. A need underscored under the covid-19 scenario and other emerging diseases in the region)

- This hub should have the capacity to lead region's surveillance in its various aspects: epidemic intelligence, data repositories, routine sero-prevalence surveys of the populations eco-epidemiological studies, implementation campaigns, vaccination (etc.). The hub should work in collaboration with other existing institutions, in particular with ECDC, WHO (which lacks a regional centre) and Africa CDC.

#2 Technologies enabling system approach for sustainable and resilient health systems and societies

- Resilient in particular in case of major crisis/disasters incorporating new knowledge and adaptation? adequate (?) policies to better adapt to ongoing climate change in the region. (CC)

#3 More equitable access to health services and technologies (in particular for the most vulnerable)

- Affordable and accessible (tools for) healthcare based on responsible and efficient use of new technologies (digitalization of the health system, educational (IT but not only) tools to increase health literacy (IT but not only?), bio-similar and bio-equivalent cost-effective drugs (?), e-clinical trials (?))

#4 Smarter and greener cities enabling healthier behavior

- Edible cities could be a good incentive for healthier food production and consumption.
- innovative incentives for the healthy behavior of the populations
- empowered and engaged citizens -> more resilient societies.
- Stimulate public and private investment on the greening of cities.

Methodological Approach

(The specific topic and technological aspect of the research has to be complemented with a comprehensive approach to research. How will the research be carried out? Which complementary research responding to some specific research questions will have to be carries out? (E.g: resource assessment, needs analysis, demand side management, market analysis, delivery and management, environmental Impact analysis, social and economic impact, etc.))

Addressing complex societal challenges, such as the health of populations in a challenging context as exposed here, requires transdisciplinary research (TDR). The transdisciplinary research method is characterized by the collaboration between natural and social scientists, as well as the involvement of non-academic stakeholders, such as public officials, citizens and commercial or not-for-profit organizations.

High level action on climate change and health: "bi- cephalic" center "e-Twinning" (coordination actions, capacity building) twinning between centres of excellence.

Case studies allow to identify key obstacles to effectively implementing transdisciplinary research, need to involve social scientists and user communities.

The activities should build on previous success either on the methodological point of view or based on the obtained results or on the developed tools: capacity building, pilot projects, participatory

research and tools (e.g., science shops) that foster transdisciplinary research multi-stakeholder engagement and recognized as a transformation path in the region (Sachs J.D. et al. 2019).

The decades of international cooperation activities conducted to the creation of a wealth of reports, initiatives, tools, training material (MOOCs) that is not necessarily visible or accessible in the ocean of information. Some support measures and coordination activities should also be conducted, this will avoid the multiplicity of fragmented initiatives and maximize the impact of the projects to be conducted.

Research and Innovation activities on implementation research is also needed for a better uptake by the population (and the various stakeholders, including health professionals) in the Euromed region with a special focus on vulnerable populations.

The activities should be evaluated through the lens of SDGs (environmental Impact analysis, social and economic impact).

#1 Pilot projects and demonstrations studies:

- Case studies to identify success elements and key obstacles to effectively implement trans-disciplinary participative research.
- Build on Euro-Mediterranean success (based on previous and new projects).
- Develop capacities in health emergency preparedness.
- Pilot projects are the occasion to learn and put into practice open science approach.

 # 2 Implementation research:

- Prevention programs.
- Health systems resilience and disaster and crisis management.
- Include Social Sciences in particular Behavioral Science, Economic Sciences, Media and Communication.

Health Scenario and link with Policy

To understand the long-term impact of the pathway it is also crucial to realise the placement of the technology within the national strategies. In order to go in this direction, the research need to respond to some further issues:

Mediterranean as a hub for Renewable energies, capacity on solar energy.

The success of future international STI collaboration for the SDGs will require a transition from competition to co-operation as the underlying principle informing innovation policy and behaviour.

#1 Identify health issues as a priority by governments and policy makers, focusing the health policy on transparency, accountability, participation, integrity and policy capacity.

- Pursuit the readiness to respond to present and future challenges, enhancing the collaborations within and beyond the health system.

#2 Implementing the political action in the access to health care, enforcing the quality of services, identifying and correctly addressing health system governance problems.

#3 The governance must aim to high quality of health standards, treatment choices and professionals' performances. changing in patients' and professionals' view of their roles, reduce health inequalities.

Desired Impact Pathway

Output

- Transdisciplinary participative responsible research and innovation based on learning organizations
- Open Accessible Data well-structured for decision making
- Digitalized health system
- A new active and comprehensive model of population involvement
- Not only smart but greener, edible and healthier cities
- Create incentives for resilient sustainable health systems (Prize on sustainability in the Mediterranean, create the Mediterranean Sustainability Index)

Outcome

- Well trained health research actors
- Well informed, “health” educated populations
- Better governance of health R&I in the Euro-Mediterranean
- Well organized sustainable and resilient health institutions (from primary to tertiary health care structures)
- Empowered both gender and vulnerable groups' health awareness
- Health services close to the territorial context and to the person itself

Impact

- Secure societies founded on values of solidarity
- More effective and safer digital health
- Healthy societies able to put into practice preventive measures and to minimize complications in case of diseases
- Resilient societies able to face crises of any type
- Sustainable and resilient health systems

4. Capacity Building Agenda and Impact Pathways

General Capacity Building Objectives

Please refer to the Knowledge Triangle (research education and innovation) and highlight how the capacity building component matches the research one to enable further, long lasting innovation.

- Mobility programs for Euro-Mediterranean Researchers in particular young researchers (Erasmus plus, MSCA) allow to develop highly skilled human resources able to tackle regional specific health challenges, build long lasting relationships between the scientific community in the region, "brain circulation" instead of brain drain and provide better career opportunities etc.
- Training should be conducted on the following issues:
- Sustainable and resilient health systems (e.g. Health specific capabilities)
- Leadership and governance for all the actors
- Health and education programs for all the stakeholders (health education and health literacy)
- Ethical, legal and regulatory capacities
- Communication and scientific mediation (capacity to involve citizens or other types of stakeholders) for knowledge transfer

Capacities required	Possible CB Activities and Formats	Outputs	Outcomes	Impact
For Researchers • Skills and competencies on how to conduct transborder transdisciplinary research. • Operationalization of open science in health research and crisis management. • Implementation research for communicable and non-communicable diseases (based on lessons learnt from the recent health crisis) • Ethical legal and regulatory capacities to conduct open science.	**For Researchers** • Demonstration activities that include pilot projects with a training dimension on defined prioritized challenges (resilient health systems, populations actively engaged in health prevention and mitigation of health risks, etc.) • Blended virtual theoretical training and "field" training with CSOs and communities (including science shop projects). • Regional MOOCs	**For Researchers** • Pilot projects • Shared regional platform for Blended training	**For Researchers** • Well trained skilled multi-disciplinary research teams. • Better knowledge on impact of climate change on health of populations in the Mediterranean. • Innovative solutions for health crisis management.	**For Researchers** • Control and lower incidence of diseases and improved management of health crisis
For Entrepreneurs • Ethical legal and regulatory issues to conduct open science, benefits and risks for entrepreneurs.	**For Entrepreneurs** • Workshops • Setting up of open living labs	**For Entrepreneurs** • Platforms to learn, share experience and test solutions	**For Entrepreneurs** • Innovative, sustainable and affordable health products and services	**For Entrepreneurs** • Resilient health infrastructure
For NGO Officers • Role of the CSO in transdisciplinary research. • Benefits and risks of open science for society	**For NGO Officers** • Theoretical and practical workshops (science café, citizen science) • Science shops to identify the unmet needs and formulate in a participative way research questions • Hackathons	**For NGO Officers** • Better trained civil society volunteers and activists	**For NGO Officers** • Effective contribution of CSO in transdisciplinary research • Unmet needs of society well identified, prioritized and well formulated	**For NGO Officers** • Responsible engaged citizens • Resilient societies able to face health crisis
For Policy Makers • Governance and regulatory aspects linked to open science, incentives for operationalization, development of evaluation and impact assessment tools • Ethical considerations in crisis and disaster management	**For Policy Makers** • Workshops • Regional strategic planning activities.	**For Policy Makers** • Adequate regulatory framework for trans-disciplinary responsible research • Shared policy platform	**For Policy Makers** • Appropriate environment for trans-disciplinary responsible research	**For Policy Makers** • New job opportunities • Resilient Health systems

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5. Relation of the research and capacity agendas to …

Renewable Energies

Despite the fact that the links between health and renewable energies seem intuitively to be indirect there are tight links and mutual influences between these two priority areas:

- Smart green edible cities based on sustainable and “healthy” sources of energy/RE will strengthen the health system
- Low-carbon lifestyles lead to:
  --> Healthier populations
  --> Resilient sustainable health infrastructure with lowered carbon footprint
- Capacity agendas should include:
- Theoretical and practical training for all the stakeholders on various pillars of open science in particular on ethical and regulatory aspects related to data access/ sharing
- Training for the various actors (researchers and policy makers) on innovative technology transfer policies and instruments.
- Transdisciplinary pilot projects and demonstration studies to test and scale up concrete solutions, to practice sustainability and resilience and to achieve the SDGs (common with CC)

Climate Change

- **Clear link between CC and health**
  Direct links:
  - New emerging and re-emerging infectious diseases (Including foodborne diseases)
  - Increase in the prevalence of chronic diseases and their complications (NCDs directly linked to CC and others already existing that are exacerbated by the CC)
  - Heat stress
  - Climate change effects on the worsening of air quality, pollution.

  Indirect links:
  - Food insecurity
  - Water insecurity
  - Vulnerable shelter and settlements
  - Extreme climatic events
  - Population migration and humanitarian crisis
- **Capacity agendas should include:**
  - Theoretical and practical training for all the stakeholders on various pillars of open science in particular on ethical and regulatory aspects related to data access/ sharing.
  - Training for the various actors (researchers and policy makers) on innovative technology transfer policies and instruments

Transdisciplinary pilot projects and demonstration studies to test and scale up concrete solutions, to practice sustainability and resilience and to achieve the SDGs (common with RE)

Rationale

A Roadmap with real transformation capacity should face the central challenges Europe as a continent also have and integrate or take advantage of the Mediterranean region in this endeavour and do not think on countries in the South-East shore as external to this concept. The Mediterranean basin and the surrounding countries have some shared problems (climate change, environmental degradation, atmospheric pollution, emerging infectious diseases threats), as well as singularities that magnify the divide between the South-East and the northern shores, between EU and northern African countries (education, health and social inequalities, technology, access to safe water…). To exert transformative change, actions taken on the three key areas (Health, Climate Change and Environment, and Renewable Energies), should be approached in a way that they bridge the political, economic and legal divide.

While truly integrative actions on all fronts are encouraged by the Expert Panel, the committee is well aware that EU and national South –East Mediterranean legislation will go against this integration, therefore a number of high-level actions are proposed that bear the capacity to exert change. All other approaches, while important and in the appropriate direction, will at most have limited impact towards the real transformation of the socioeconomic, educational and RDI landscape in the Euro-Mediterranean region.

Europe has important challenges from which at least a number of those have its highest expression also in the Mediterranean region, and they are also the centrepiece of this roadmap, namely Health, climate change and renewable energies. We propose that one of the center of investments for the advancement in science and technology be located in the Euro-Mediterranean countries. The Euro-Mediterranean Sea countries face extreme environmental degradation due to an aggressive urban growth policy and the limited protection of natural environments, aggravated by the ongoing climate change crisis. As also one of the main hotspots for climate change on Earth, the Euro-Mediterranean region (both North and South-East) will face an escalade in the impacts at all levels of society,

environment but also economy, and clear action should be taken immediately to begin adapting to those changes and mitigate harsh impacts. The former will inevitably have a large and negative effect on health and economy at all levels and sectors in our population. To partially remedy this inevitable outcome, massive investment on RDI must be executed and the Euro-Mediterranean area is an optimal testbed for all those transformative initiatives.

Proposed actions

Establishment of a Program towards the implementation of 'EuroMed Joint-Research centre' on the 3 key areas (Health, Climate Change, Environment and Renewable Energies). This EuroMed JRC would have a bi-cephalic brotherhood structure with one physical headquarter in the Northern countries and another in the South-East Mediterranean. The partnership would include two head offices that would be similar in structure and funding and be the bridge to the EU on the one side and the Northern African countries on the other. Circulation of resources, scientists, technologist and projects would be common and free under a same and unique umbrella, so that mechanisms are to be put in place to facilitate this effective movement. Access to EU RDI Programs would be allowed for these centres on an equal basis as if those were made from within Member States (gateways to the future). Similarly, specific technological and innovation projects would be initiated and implemented jointly throughout these JRC and without limitations in both the northern and the South-East shore, in the same conditions as if they were done by EU member states institutions themselves.

This way a EUMed-JRC on Health, Climate Change or RE would have an interconnected structure that would overcome regulatory and legislation divides between EU and non-EU countries. High-level funding would be specifically allocated so that top-notch RDI would be conducted at these central places to which Universities and Research centres (for instance those in the southern shore) could associate to access and participate in all EU mechanisms of research funding.

Promotion of transdisciplinary work as well as improving water-food-energy-health nexus literacy should be among the missions of this EU-MED-JRC.

Draft Theory of Change and Impact Pathway

Technical Experts' Group on
Research and Innovation

Situation Analysis

1. SWOT
2. Problems | Causes
3. Context & Stakeholder Analysis
4. Further Details

Roadmap and Impact Pathway

1. SWOT

The following table illustrates the SWOT Analysis of Renewable Energy (RE) situation in Mediterranean Countries (MC). There are many RE situations that are common in both North Mediterranean Countries (NMC) and South-East Mediterranean Countries (SEMC). However, there are various RE issues that specifically are related to either NMC or SEMC.

STRENGTHS

- Increasing awareness within UfM Countries about the importance of supporting RE being environmentally friendly resources.
- RE are based on stable sources, especially in UfM Countries.
- NMC have a quite established policy/culture on RE under the stimulus of the cooperation mechanism developed by EU.
- RE are a key factor in the battle against climate change and in general towards industrial/electrical power system modernization.
- Wind and Solar Atlases show high potential for RE applications especially in the SEMC and especially with regard to electricity generation, high solar irradiance and wind speed.
- SEMC have large land areas (mainly deserts) that are suitable for RE applications.
- MC are leading some of the higher RE facilities in the world, especially in PV and thermal technologies.
- RE provides electricity to national distribution grid, thus possibly limiting the use of batteries known for their toxicity and high costs.

OPPORTUNITIES

- Great tapped potential of RE in UfM Countries in comparison to EU.
- RE provides new business opportunities.
- RE show an export potential between SEMC and Europe through the Mediterranean Ring and direct interconnections between SEMC and NMC.
- Revive the DESERTEC project (https://www.desertec.org/) (installing PV power plants in SEMC and exporting this electricity to NMC).
- The share on information/data on RE among UfM Countries could inspire and stimulate the development of related common policies. In addition, it will bring positive social impacts.
- The growth of population triggers a significant increase in energy demand, that could be provided by RE.
- Most of the NMC lack of oil & gas then RE support is a must.
- Some multilateral initiatives can support R&D cooperation in RE between UfM Countries such as PRIMA, ENI CBC MED or LEAPRE.
- The existence of a RE Adhoc group at Mediterranean Regulators (MedReg) can help in providing an up to date RE status at MC along with the current regulations and plans.

WEAKNESSES

- The management and the development of strategies on RE require a common and harmonized smart database for gathering information (Energy big data processing issue is still unexplored among UfM Countries).
- Within UfM Countries, there is a fragmented and diversified state of the art regarding RE applications/ regulations/taxes scheme and this could give rise to energy vulnerability in the area.
- The exchange of experience/best practices regarding RE is still unstructured among UfM Countries and among the local National Authorities and Stakeholders on energy matter.
- RE requires integrated and advanced technologies that are not uniformly developed among UfM Countries (mainly in the direction of electrification end-uses).
- Interconnectivity among national grids is not fully developed, especially in SEMC.
- The problem of injection of excess electricity production is still a major problem in many MC in particularly for the SEMC where the liberalization of the electricity sector is limited.
- Actual RE data is considered confidential and not to be exchanged in most of the SEMC.
- Policy makers have some worries regarding the use/spread of RE technologies (i.e. fear of change into new weather-related technologies).
- Lack of modernization of distribution systems (grids) hinders the injection of high RE penetration.
- The volatility of RE operation increases the complexity of distribution systems operation and some related issues such as identifying non-commercial losses (theft) in existing networks.
- Weak transnational partnerships that are needed to address the critical R&I priorities
- Poor cooperation between private sector and academic researchers

THREATS

- RE require high investment costs that are not affordable by all UfM Countries.
- The Mediterranean area is highly threatened by climate change negatively impacting RE potential (dust in PV plants, desertification that involves biomass reduction, water scarcity, etc.).
- To neglect the necessity of promoting RE could increase the gap between the rates of economic and social growth between UfM Countries.
- The focus on RE production must be followed by upgrading of the electric grid, storage systems, and consumption infrastructure (i.e. Smart Grid and Smart Cities promotion).
- Digitalization of the energy grid require new ICT technologies and infrastructure, not always available in the UfM Countries, especially in the SEMC.

2. Problems | Causes

A. What are the problem areas?

The scenario appears diversified among the NMC and SEMC. The NMC have a quite established policy on RE under the stimulus of the cooperation mechanism developed by EU.

The EU policy addresses the final goal of creating a Europe's internal energy market, set up under the RE Directive. Among the most important issues, the following have been focused by EU policy:

- statistical transfers
- joint projects
- joint support schemes

On the other hand, in the SEMC the awareness on the importance of RE is increasing, but it appears less structured.

At the same time, literature data, reveal that primary energy demand in the Mediterranean basin will be 1.5 times higher in 2025 compared to 2006 and that the SEMC could experience growth rates four times higher (especially regarding electricity demand) than those of the NMC. This is due to the fact that SEMC are in full development process and their population is increasing significantly. RE potential in MC is in general considerable and largely under-tapped, especially in the SEMC. Different approaches among UfM Countries are also a consequence of different institutional support to RE (incentive policies) and of different regulatory schemes that imposes specific target on the share of RE.

B. Which are the causes and the underlying knowledge- and capacity related causes?

The fragmented situation regarding RE in MC is related to several aspects among which:

- Different maturity of both economy, technology, and infrastructures related to energy
- Different awareness of the need of institutional coordination on energy matter
- Different availability of natural resources (both fossil and renewable)
- Different awareness of environmental issues

3. Context Analysis | Stakeholder Analysis

It is necessary to involve the local National Authorities on Energy matter, to make operative and to give impetus to RE plans in UfM Countries. Besides, due to increasing the RE production, the whole infrastructure stakeholders (transport, storage, consumption, interconnectivity among countries) should be also involved.

More investments from both the private and public sectors of UFM countries in joint R&D projects are needed in RE and Energy Efficiency (EE) fields.

Due to recurring dryness, support the SEMC to develop PV, wind, and solar power plants which will be used for desalination of seawater at low cost and thus guarantee the political stability and economic development of these countries is a must. Furthermore, RE can play a key role to guarantee the political stability and economic development of isolated areas by providing energy to develop them socially and economically.

Various stakeholders should be involved in the RE analysis such as Researchers, Entrepreneurs, Non-Governmental Organization (NGO), and Policy Makers. The RE Analysis results should be discussed in a public hearing workshop.

4. Further Details | None

Renewable Energies #1

Roadmap and Impact Pathway

Overview of RE Scenarios, harmonized RE Smart Database and Communication within UfMC

1. Specific challenges:

A cooperative scenario regarding RE within UfM Countries could be possible only if a structured database about energy from renewable sources is available. EU and Northern Mediterranean countries have already addressed this issue, i.e. developing a standard harmonized calculation method to monitor the share of energy from renewable sources. This tool is an open one and its application prevents any irregularities from varying parameters and rules used in different calculation methods. https://ec.europa.eu/eurostat/web/energy/data/shares.

This allows for instance monitoring some defined quantities, such as:

- Share of renewable energy in gross final energy consumption (total) %
- Renewable energy sources in transport %
- Renewable energy sources in electricity %
- Renewable energy sources in water treatment %
- Renewable energy sources in heating and cooling %
- Environmental impacts of use of Renewable energy sources (LCA assessment)

and others related to the overall energy balance of each country, such as:

- The Gross available energy
- The Total energy supply
- Primary Energy Consumption
- Energy available for final consumption

In the framework of the relations between Europe and the Mediterranean Countries, it appears strategic to plan a similar tool that could include the member countries of the UfM. In this context, cross cutting issues are related to the development of energy efficiency, reduction of GHG and carbon dioxide emissions.

2. SDGs

This roadmap and its impact pathway are contributing to the following SDGs:

SDG	Comment
	Adopting a standard approach in evaluating RE scenarios contributes to make cities and human settlements more sustainable
	Adopting a standard approach in evaluating RE scenarios stimulates a sustainable energy consumption

SDG	Comment
	Adopting a standard approach in evaluating RE scenarios can significantly contribute to the reduction of the impacts of climate change
	Adopting a standard approach in evaluating RE scenarios ensure access to reliable and sustainable energy for all.
	A cooperative scenario stimulates equitable global rules

3. Research & Innovation Agenda

Technological development and efficiency

(The specific topic and technological aspect of the research has to be investigated under components and system point of view. To which specific questions does the technological research respond to?)

#1 Identification and definition of the quantities relevant for a Renewable Energies scenario:

- Is there a standard and harmonized method to define and calculate relevant quantities in RE analysis with the aim of potential mapping as well?

#2 Identification of database that could be shared within UfM countries:

- How is it possible to analyze the state of the art and possibly historical data on RE within UfM Countries?

#3 Stimulating the share of information/best practice in RE policy:

- Is there a sector among transport/heating and cooling/electricity in which the % of RE sources is mostly increased in the last years?

Methodological Approach

(The specific topic and technological aspect of the research has to be complemented with a comprehensive approach to the research. How will the research be carried out? Which complementary research responding to some specific research questions will have to be carried out? (E.g.: resource assessment, needs analysis, demand side management, market analysis, delivery and management, environmental impact analysis, social and economic impact, etc.)

#1 Identification and definition of the quantities relevant for the Renewable Energies scenario:

- A common base document/scheme of the database has to be developed

#2 Identification of database and related digital platform that could be shared within UfM Countries:

- A common database / digital platform has to be developed

 # Stimulating the share of information/best practice in RE policy:

- Open shared databases and documents must be produced, evaluating social, environmental and economic impact of RE, focusing also on a life-cycle approach

Renewable Energy Scenario and link with Policy

To understand the long-term impact of the pathway it is also crucial to realise the placement of the technology within the national strategies. In order to go in this direction, the research need to respond to some further issues:

#1 feasibility of defining a route to the definition of standard quantities and of a harmonized calculation method about RE scenario analysis
#2 stimulating a cooperative approach and an efficient partnership within UfM Countries with regards to RE
#3 feasibility to share best practice in RE policy adopted by each country, starting from the analysis of their impact on the different final sectors
#4 encouraging policies to increase the diffusion of RE within UfM Countries thus producing economic opportunities, by indirectly providing a long-term support to social justice, youth and women issues

Desired Impact Pathway

Output

- Standard and harmonized approach in evaluating RE scenarios

Outcome

- Development of a database and a digital/smart big-data platform focused on RE that could be shared among UfM Countries

Impact

- Inspiring and stimulating a sharing of experience on RE policy
- Enforcing innovation processes by means of cooperation between Universities, Companies and local Authorities also encouraging joint communication and educational programs

4. Capacity Building Agenda

General Capacity Building Objectives

Please refer to the Knowledge Triangle (research education and innovation) and highlight how the capacity building component matches the research one to enable further, long lasting innovation.

Capacities required	Possible CB Activities and Formats	Outputs	Outcomes	Impact
For Researchers • Real historical data, maps, equipment specifications on RE data.	**For Researchers** • Workshops discussing international experiences and types of required data and format.	**For Researchers** • Reliable analysis / simulation models • Digital platform for the management of energy smart database	**For Researchers** • To do the first steps in the path towards a research infrastructure for knowledge management and communication	**For Researchers** • Stimulating a comparative/critical analysis on RE within the UfM Countries and then stimulating a share of experience
For Entrepreneurs • Training on statistical data analysis to develop activity in the energy management.	**For Entrepreneurs** • Workshops with hands on applications on real data collection approach with regards to RE.	**For Entrepreneurs** • Creating a database useful for statistical analysis on RE data to develop strategic planning.	**For Entrepreneurs** • Stimulating the exchange of experience of RE data analysis	**For Entrepreneurs** • Develop technological transfer on RE
For NGO Officers • Training on conducting awareness campaigns showing the positive impact on applying such research activities.	**For NGO Officers** • Workshops on preparing and carrying out awareness campaigns on RE management on large scale.	**For NGO Officers** • Creating a network among national authorities related to Energy matter that can stimulate accredited opinion in the field of RE promotion.	**For NGO Officers** • Public hearing procedure approved by the distribution utilities.	**For NGO Officers** • Involvement of national authorities in the RE sector activities and cooperation among them.
For Policy Makers • International experiences in the topics under study as an evidence for the importance of these issues.	**For Policy Makers** • Set of seminars, online webinars, and/or online discussions with policy makers with international experiences.	**For Policy Makers** • Assigning short term twinning / agreements with entities abroad that have such practical experience.	**For Policy Makers** • Draft of policies that could identify best practices and incentives.	**For Policy Makers** • Develop a cooperative approach on RE policy and within a "Green Deal" scenario

References

- *EUROSTAT Energy balances*
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- *Share of energy from renewable sources*
  *https://appsso.eurostat.ec.europa.*eu*/nui/show.do?dataset=nrg_ind_ren&lang=en*
- *Use of renewables for transport*
  https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_ind_urtd&lang=en
- *Use of renewables for electricity*
  *https://appsso.eurostat.ec.europa.eu/nui/*show*.do?dataset=nrg_ind_ured&lang=en*
- *Use of renewables for heating and cooling*
  *https://appsso.eurostat.ec.europa.eu/nui/show.do?*dataset*=nrg_ind_urhcd&lang=en*
- *United Nations Statistics Division UN Energy Balances*
  https://unstats.un.org/unsd/energystats/pubs/balance/

5. Relation of the research and capacity agendas to …

Health

- The adoption of a standard approach in evaluating RE scenarios contributes to improve the efficiency of the RE sources leading to health impacts, in terms of occupational health risks and household and ambient air pollution.

Climate Change

- RE are a key factor in the battle against climate change, therefore the development of a structured database about energy from renewable sources aimed at adopting a standard and harmonized approach in evaluating RE scenarios can significantly contribute to the reduction of the impacts of climate change, starting from the support in the definition of a common strategy within UfMC. At the same time, climate variability could impair the availability of water and then the electricity production from RE.
- Furthermore, the availability of databases on the life-cycle eco-profiles of RE technologies can assist in defining decarbonization strategies based not only on the operational phase of the technologies but also on their whole life cycle.

Renewable Energies #2

Roadmap and Impact Pathway

Modernization of the electric power systems (Smart Grid, Smart Cities and local RE generation)

1. Specific challenges: to develop isolated and rural areas thanks to digitalization and RE.

Rural and isolated areas in both Northern and South-East Mediterranean shores usually lack of a stable, sufficient and reliable access to energy (due to the lack of energy transport infrastructure, high investments required for fewer population, etc.). This situation could involve political issues such as:

- Climate change involves, among other impacts, scarcity of water and land desertification. Available water sources and unfolding other economic activities than traditional agriculture are necessary to develop rural areas. Agritech is an example but other activities requiring digitalization and modernization could be also important. More in general, important issues towards a sustainable modernization scenario based on RE arise also from so called “Food System”, intended as the multidisciplinary interconnected environment/community, comprising the constellation of activities involved in producing, processing, transporting and consuming food.
- The growth of population will be very high in the following decades, especially in SMC. Therefore, accessing to stable energy and water sources and raising economic opportunities is paramount to avoiding youth people to leave those areas.
- COVID-19 is taking the population living in the cities to rural areas looking for a quieter and healthier environment, especially in NMC. This migratory movement could be answered also with digitalization and modernisation of the overall energy system in order to retain them in those areas thanks to teleworking or other economic activities.

By the way, ICT has undergone an outstanding development throughout the last decades. Concepts like Smart Cities, Big Data, IoT or Industry 4.0 are nowadays technology trends that must be fully related to energy management (production, storage, transport and consumption). Digitalization and local energy generation (smart grids, wind farm, biomass, geothermal, waste to energy, etc.) allow this scenario not being anymore only applied in cities but in rural areas. This strategy has to be coupled to a modernization of the overall energy system toward an electrification of end uses approach, that could take into account not only energy production but energy storage, sustainable mobility.

Therefore, it is necessary to digitalize the development of the RE policy in the UfM countries to provide social and economic opportunities to the most vulnerable areas in the region.

2. SDGs

This roadmap and its impact pathway are contributing to the following SDGs:

SDG	Comment
	Having a reliable energy production and management could foster inclusion through social and economic activities in less developed locations.

SDG	Comment
	In addition, in the food treatments a sensible energy management can allow beneficiaries to avoid food waste and to improve the agriculture sector thanks to ICT.
	Water management can be improved thanks to combining RE and ICT in desalinization plants and water distribution.
	Ensuring access to reliable and sustainable energy for all.
	Appling ICT in rural and isolated areas in addition to a stable energy source thanks to RE could open plenty of economic opportunities, namely to youth people thanks to reducing the gap with cities.
	Tackling the challenges explained in this roadmap could boost the innovation and industry in rural and isolated areas.
	Smart grids could make cities and towns become more sustainable and turn them into smart cities.
	Developing RE generation fosters sustainability, allows population to face climate change impact and save other non-clean resources.

3. Research & Innovation Agenda

Technological development and efficiency

The specific topic and technological aspect of the research has to be investigated under components and system point of view. To which specific questions does the technological research respond to?

#1 Matching energy production/storage/consumption:

- What size of population or investment does make this system affordable? How is it possible to combine rural activities such as livestock or farming production with small-scale renewable energy production and storage systems? Could this system overcome demographic constraints (low load density and limited access) and consumer profile limitations (decentralized consumer, old-age population profile, second residency profile)?

#2 Technical capabilities to self-management.

- How the smart village could involve an easy management in order to assure it having remote access to experts? How could a low-intervention management be achieved?
- How overcome technological challenges concerning off the grid smart cities related to lack of external supply grid or low penetration of green ICTs?

#3 Digitalization & Renewable Energies & Isolated activities.

- When we talk of digitalization, rural or isolated areas are usually not addressed by. These technologies are expected to apply on “large city scale” approach and they count with important limitations for their applications in less populated environments or in surrounding areas of the city. How the technology can become affordable enough to coping these citizen’s

needs? Could IoT, Industry 4.0, etc. be applied in that environment? Could renewable energies and storage systems make them totally self-sufficient off the grid?

Methodological Approach

The specific topic and technological aspect of the research has to be complemented with a comprehensive approach to the research. How will the research be carried out? Which complementary research responding to some specific research questions will have to be carried out? (E.g: resource assessment, needs analysis, demand side management, market analysis, delivery and management, environmental impact analysis, social and economic impact, etc.)

#1 Analysis of energy management, production and storage systems and specifications regarding less populated areas´ needs:

- Needs analysis, market analysis, social and economic impact, cost analysis.

#2 Development of energy production and storage technologies and its integration to suit these areas´ activities:

- Electrical and thermal architecture design, integration, storage, matching demand.

#3 Digitalization of management system to become a smart city system self-sufficient

- Technologies selection, prototyping, validation, testing, adaptation to other activities (agriculture, farming, housing, etc.)

Renewable Energy Scenario and link with Policy

To understand the long-term impact of the pathway it is also crucial to realise the placement of the technology within the national strategies. In order to go in this direction, the research needs to respond to some further issues:

#1 Applied Research & Technology Development 3<TRL<7 for the technology development

#2 Higher TRLs for the final real test in the living lab

Other strategies addressed by the project: rural development, social impact, youth employment, among others.

Desired Impact Pathway

Output

- Identification and development of an integrated and digitalized system to become a Smart Village or City involving Renewable Energies production and storage coupled to population activities and ecosystem conditions.

Outcome

- Obtain small-scale digitalized sustainable Smart Village systems.
- Answering population needs in terms of sustainability and self-sufficiency in aspects like energy, production activities and circular economy.
- Developing rural areas thanks to providing better life conditions (different economic activities, youth opportunities, etc.)

Impact

- Increase the self-sufficiency in rural and isolated areas. Save investments because no connection to the grid is needed. Diversification of economic environment due to the self-sufficiency.

4. Capacity Building Agenda

General Capacity Building Objectives

Please refer to the Knowledge Triangle (research education and innovation) and highlight how the capacity building component matches the research one to enable further, long lasting innovation.

Capacities required	Possible CB Activities and Formats	Outputs	Outcomes	Impact
For Researchers • Adapting energy production and storage technologies to small-scale.	**For Researchers** • Workshops discussing international experiences and types of required data and format.	**For Researchers** • Reliable analysis/ simulation models • Lab testing	**For Researchers** • Smart system matching energy and ICT technologies.	**For Researchers** • Obtaining new developments adapted to the restricted conditions exposed.
For Entrepreneurs • Obtaining technological solutions adapted to smart villages. • Integration ICT and Renewable Energies production and storage technologies to get a resilient, self-sufficient system off-grid.	**For Entrepreneurs** • Workshops on smart cities. • Incubation and pilot initiatives.	**For Entrepreneurs** • New ICT trends applied to rural ecosystems. • Pilot living labs.	**For Entrepreneurs** • Real system matching needs of rural population in terms of energy and ICT to become self-sufficient.	**For Entrepreneurs** • Testing complex systems combining ICT and Renewable Energies in real environment.
For NGO Officers • Educating the population in terms of efficiency, activities scheduling (to adapt them to energy production). • Raising awareness of the system and its benefits.	**For NGO Officers** • Workshops on preparing and carrying out awareness campaigns and public hearing activities on utility scale. • Capacity building to prepare skilled citizens to manage the system.	**For NGO Officers** • Creating NGO that can handle utility scale awareness campaigns and public hearing activities.	**For NGO Officers** • Public hearing procedure approved by the distribution utilities.	**For NGO Officers** • Involvement of NGO in the electricity sector activities. • Mobilizing population in the management and maintenance of the system.
For Policy Makers • International experiences in such topics under study as an evidence for the importance of these issues. • Urban planning, social involvement, rural development.	**For Policy Makers** • Set of seminars, online webinars, and/or online discussions with policy makers with international experiences.	**For Policy Makers** • Real experience of a living lab smart village.	**For Policy Makers** • Policies to develop rural locations. • Social development and mobilization of workers from the city to the villages.	**For Policy Makers** • Increasing wealth in the rural areas. • Stabilization of the rural population, especially the youth. • Modernization of rural activities like agriculture or farming. • Creation of skilled employments in the rural areas. • Promotion of social housing in rural locations. • R&D has to contribute to the skill opportunities for young people coming from the less developed countries who undertake to return to work for the good of their country

References

- Joint Communication for a Comprehensive Strategy with Africa adopted on 9/3/2020 https://ec.europa.eu/international-partnerships/priorities/eu-africa_en
- R&I Partnership on Climate Change and Sustainable Energy of the EU/AU High-Level Policy Dialogue on Science https://ec.europa.eu/research/iscp/index.cfm?pg=africa
- Partnership for Research and Innovation in the Mediterranean Area (PRIMA) https://prima-med.org/

5. Relation of the research and capacity agendas to …

Health

- Having a stable and reliable production, management and consumption of energy (thanks to combining RE and ICT) can improve the life conditions of the human beings by providing them better access to drinkable water, more productive crops and livestock, better maintenance of vaccines or IT health.

Climate Change

- Combining RE and ICT can help to tackle water scarcity (thanks to desalinization plants), farming system productivity (use of agritech, etc.), to ensure land and water conservation (thanks to stabilization of population in rural and isolated areas)

Renewable Energies #3

Roadmap and Impact Pathway

Distribution system modernization (Energy Loss Management)

1. Specific challenges:

The electrical distribution systems losses can be considered, in many parts of the world, as a tremendous leak in the electricity supply chain. It negatively impacts the cash flow especially from sales of electricity at distribution companies that increases their debt and generally on the electricity tariff.

2. SDGs

This roadmap and its impact pathway are contributing to the following SDGs:

SDG	Comment
	Detecting electric distribution losses can help in reducing unnecessary electricity generation and thus reduces cost of generation and thus electricity tariffs.
	Modernizing Electric Distribution Systems and reducing governmental spending on electricity leak in the system will increase pay back of consumed electricity, develop the electricity sector economic growth.
	Working on smartening the electrical distribution systems ensures a continuous supply of electricity to consumers that will lead to sustainable cities' creation and growing communities.
	Energy management of electricity consumption is a main goal of electrical distribution systems modernization.
	Reducing spending on electrical losses especially the commercial one will save money for promoting renewable energy generation. It will positively have a direct impact on climate actions.

3. Research & Innovation Agenda

Technological development and efficiency

The specific topic and technological aspect of the research has to be investigated under components and system point of view. To which specific questions does the technological research respond to?

#1 Identification of technical / commercial loss zones:

Is there an affordable methodology to differentiate between technical loss due to aging and commercial loss is widely spread distribution networks?

#2 Identification of loss zones in systems impeded with customer-owned renewable-based Distributed Generation (DG).

What is the impact of renewable-based distributed generation on identification of system loss zones?

#3 Developing a relation between the electric loss percentage and electricity tariff.

Is there a methodology to correlate between electrical / commercial loss and cash flow / electricity tariff estimated on preventive maintenance existing approaches?

Methodological Approach

The specific topic and technological aspect of the research has to be complemented with a comprehensive approach to the research. How will the research be carried out? Which complementary research responding to some specific research questions will have to be carries out? (E.g: resource assessment, needs analysis, demand side management, market analysis, delivery and management, environmental impact analysis, social and economic impact, etc.)

#1 Identification of technical / commercial loss zones:

Needs analysis, market analysis, social and economic impact

#2 Identification of loss zones in systems impeded with customer-owned renewable-based Distributed Generation (DG):

Needs analysis, market analysis, environmental impact analysis

#3 Developing a relation between the electric loss percentage and electricity tariff.

Needs analysis, social and economic impact

Renewable Energy Scenario and link with Policy

To understand the long term impact of the pathway it is also crucial to realise the placement of the technology within the national strategies. In order to go in this direction, the research needs to respond to some further issues:

#1 will there be a practical preventive maintenance plan that reflects the actual system?

#2 will the maximum renewable-based DG on the distribution feeders change considerably?

#3 will the reduction of system loss impact tariff structure distribution (cross subsidy)?

Desired Impact Pathway

Output

- Identification of electric system loss zones accurately with affordable methodology.

Outcome

- Reduce system losses based on technical approach by applying practical preventive maintenance plans.

Impact

- Reduction in electricity tariff. Reduce the debt and increase profitability of the electricity sector in general and specifically in the distribution companies. Pave the way for competitive private business in the distribution system.

4. Capacity Building Agenda

General Capacity Building Objectives

Please refer to the Knowledge Triangle (research education and innovation) and highlight how the capacity building component matches the research one to enable further, long lasting innovation.

Capacities required	Possible CB Activities and Formats	Outputs	Outcomes	Impact
For Researchers • Real historical data, maps, equipment specifications in distribution systems.	**For Researchers** • Workshops discussing international experiences and types of required data and format.	**For Researchers** • Reliable analysis / simulation models	**For Researchers** • Detailed study of a pilot distribution company zone that can be replicated on the whole distribution system.	**For Researchers** • Showing the net saving with its accuracy of the pilot distribution company zone under study.
For Entrepreneurs • Training on system loss measurements and identification to start companies in the preventive maintenance / energy management activities on the utility level. •	**For Entrepreneurs** • Workshops with hands on applications on real measurements apparatus that is used in such studies. • Field trip training (abroad) to show hands on activities.	**For Entrepreneurs** • Creating entrepreneurs in the field of utility scale measurements and energy management.	**For Entrepreneurs** • Create an outsourcing entity that distribution companies rely on and alleviate the burden on distribution companies.	**For Entrepreneurs** • Create experienced hands-on personnel whom open new activities that facilitates activities under the planned private distribution electricity business.
For NGO Officers • Training on conducting awareness campaigns showing the positive impact on applying such research activities.	**For NGO Officers** • Workshops on preparing and carrying out awareness campaigns and public hearing activities on utility scale.	**For NGO Officers** • Creating NGO that can handle utility scale awareness campaigns and public hearing activities and accredited by distribution companies.	**For NGO Officers** • Public hearing procedure approved by the distribution utilities.	**For NGO Officers** • Involvement of NGO in the electricity sector activities.
For Policy Makers • International experiences in such topics under study as an evidence for the importance of these issues.	**For Policy Makers** • Set of seminars, online webinars, and/or online discussions with policy makers with international experiences.	**For Policy Makers** • Assigning short term twinning / technical assistant (TA) agreements with entities abroad that have such practical experience.	**For Policy Makers** • Draft of policies that engages electricity stakeholders.	**For Policy Makers** • Fair electricity pricing with less cross subsidy burden on consumers. • Social relief from unrealistic electricity bills.

References

- Forum of Regulators, “Best practices and strategies for distribution loss reduction Final report“, July 2016. Available [Online]: http://www.forumofregulators.gov.in/Data/study/11.pdf
- European Commission - Energy, “Study on tariff design for distribution systems,“ January 2015. Available [Online]: https://ec.europa.eu/energy/sites/ener/files/documents/20150313%20Tariff%20report%20fina_revREF-E.PDF
- The Egyptian Electricity Holding Company Reports.

5. Relation of the research and capacity agendas to …

Health

- Modernizing electrical distribution systems reduces distribution losses that might cause health hazards. Loss reduction will decrease government spending on unnecessary generation and can be used for social health spending. In the meanwhile, reducing loss spending will reflect on electricity tariff values which increases customers’ savings from electricity bills. These savings can be used to improve personnel spending on their health.

Climate Change

- Modernizing electrical distribution systems helps in detecting distribution losses location and causes that in return reduces electricity generation. This reduction will reduce greenhouse gases emissions caused by burning fossil fuel and thus lessen climate change.

Renewable Energies #4

Roadmap and Impact Pathway

Advanced technologies | Green hydrogen production, storage-and infrastructures implementation

1. Specific challenges:

The solar hydrogen may be the sustainable energy key of the future. It can be safely produced by water electrolysis using RE sources like solar, household waste and wind power or directly by photosynthesis way. The proximity and the tremendous abundance of renewable sources in SMC are favourable to the creation of scientific, technical, and economic cooperation and partnership between the two Mediterranean sides (SMC and NMC) in the green H2 production, storage and distribution.

2. SDGs

This roadmap and its impact pathway are contributing to the following SDGs:

SDG	Comment
	Clean, reliable, and sustainable energy production would promote better lives, healthiness, and a sense of security for the population.
	Energy created through REs plants has a higher number of jobs created per unit of energy produced than energy produced through conventional sources.
	Developing the H2 sector by solving storage problems and creating distribution infrastructure will help solve the problems of intermittency of RE sources and thus make energy affordable and sustainable.
	Tackling the challenges explained in this roadmap could boost the innovation and industry in rural and isolated areas.
	REs funding mechanisms can create significant employment and gender equality effects, especially for women and young graduates in poor regions.
	The use and proper management of RE in a rational way (smart grid, artificial intelligence, space control, etc.) would make it possible to reduce polluting gas emissions, thus helping to improve the quality of the atmosphere, water and oceans.

3. Research & Innovation Agenda

Technological development and efficiency

The specific topic and technological aspect of the research has to be investigated under components and system point of view. To which specific questions does the technological research respond to?

#1 Identification of the best hydrogen production process using renewable energies to resolve and compensate the intermittency and excess of electricity production of these resources:

- Among the technics to produce H2, what is the effective, the safe and the adapted one?

#2 Resolve the problems of storage and the transport of green H2 between South-East and North Mediterranean Countries:

- What is the safe and efficiency process to exchange the hydrogen produced between the SMC and NMC?

#3 Development of research in the field of H2 distribution networks and infrastructures in Mediterranean countries:

- How can R&I on both sides of MC help to establish a vision on this point and create topics for cooperation between researchers?

Methodological Approach

The specific topic and technological aspect of the research has to be complemented with a comprehensive approach to the research. How will the research be carried out? Which complementary research responding to some specific research questions will have to be carries out? (E.g: resource assessment, needs analysis, demand side management, market analysis, delivery and management, environmental impact analysis, social and economic impact, etc.)

#1 Identification of the solar energy processes which can be conducted to produce hydrogen: water electrolysis using solar generated electricity or direct solar water splitting.

- The electrolysis of water is good controlled however more improvement still necessary to reduction the size of PEM fuel cell and rise its efficiency.

#2 A combination of solar and wind power or others REs can provide a high load factor for the electrolysis process, and so lead to competitive cost of green hydrogen:

- The energy management in both sense of production and consumption sill a problem to resolve and improve.

#3 The cost of electricity production from Renewable energies should fall more in the future for sites with good solar and wind resources (<10-20 € per MWh).

- Identification of the sites with good wind and solar irradiation In Mediterranean countries. Study the social, environmental and economic impact on the population.

Health/Renewable Energy/Climate Change Scenario and link with Policy

To understand the long-term impact of the pathway it is also crucial to realise the placement of the technology within the national strategies. In order to go in this direction, the research needs to respond to some further issues:

#1 Will there be an existing approach between MCs, upstream and downstream, to create collaborations and exchange of data in this area?

#2 Applied Research, Technology & Artificial Intelligence (IA) to improve and manage the hybrid RE systems.

#3 Are MC countries and their leadership aware of and know the importance of renewable energies? And are they ready to invest in it?

Desired Impact Pathway

Output

- Identification of the best process to convert REs into H2 energy and seek to develop research in its storage and distribution infrastructures.

Outcome

- Increase the efficiency of the solar conversion of hydrogen and reduce the costs of storage, transport, conversion into electricity.

Impact

- Reduction of the price of H2 production less than 1euro per kg. avoid the harmful gases (CO2, N2O…) responsible for greenhouse emissions. Creation of jobs in SMCs and thus reduce illegal immigration.

4. Capacity Building Agenda

Please refer to the Knowledge Triangle and highlight how the capacity building component matches the research one to enable further, long lasting innovation.

Capacities required	Possible CB Activities and Formats	Outputs	Outcomes	Impact
For Researchers **For Researchers** • Managing the solar H2 production, storage distribution Infrastructures and conversion of fuel green energy • Work on new materials for converting solar energy into hydrogen such as perovskites. Materials, semiconductors of intermediate band gap, photocatalysis…	**For Researchers** • Workshops discussing international experiences and types of required data and formation	**For Researchers** • Reliable analysis / simulation models • Prototype for demonstration and study of the conversion, storage and distribution of green H2	**For Researchers** • Improve the conversion efficiency of solar hydrogen • Reduce the size and autonomy of H2 fuel cells to be more suitable for cars	**For Researchers** • Making Mediterranean cities and countries inclusive, safe, resilient and sustainable in the future
For Entrepreneurs **For Entrepreneurs** • Development of prototypes of solar hydrogen production and application as fuel power for cars	**For Entrepreneurs** • Workshops with practical applications on a real prototype for the conversion and supply of H2 energy vector	**For Entrepreneurs** • Creating entrepreneurs in the field of green H2, solar and wind power	**For Entrepreneurs** • Encourage the private sector to invest and participate in the production or / and management of solar hydrogen	**For Entrepreneurs** • Training of a qualified workforce in the field of RE and involvement of citizens in the maintenance and safety of installations
For NGO Officers **For NGO Officers** • Training on conducting awareness campaigns showing the positive impact on applying such research activities	**For NGO Officers** • Workshops to prepare and carry out awareness campaigns and public hearing activities at the level of public services	**For NGO Officers** • Workshops on preparing and carrying out awareness campaigns and public hearing activities on utility scale. • Capacity building to prepare skilled citizens to manage the system	**For NGO Officers** • Public hearing procedure approved by the distribution utilities	**For NGO Officers** • Involvement of NGOs in renewable energy and environmental protection activities
For Policy Makers **For Policy Makers** • Financing and monitoring of renewable energy projects and innovative ideas in the field • Creation of distinctive awards for the best projects	**For Policy Makers** • Set of seminars, meetings in the form of online webinars and / or online discussions with policy makers with international experiences	**For Policy Makers** • Assigning short term twinning / technical assistant (TA) agreements with entities abroad that have such practical experience	**For Policy Makers** • Immediate and effective action in response to the intensification of climate change, which today constitutes a serious threat to humanity	**For Policy Makers** • Encourage the marketing of solar hydrogen cars. • State subsidy of green electricity • Improve and reform laws on the supply and sale of solar energy from Res • R&D has to contribute to the skill opportunities for young people coming from the less developed countries who undertake to return to work for the good of their country

References

- Energy Policies Beyond Countries Morocco 2019 Review
- Nations Unies: 68th United Nations Civil Society Conference

5. Relation of the research and capacity agendas to …

Health

- Clean and sustainable hydrogen production would promote better lives, healthiness, and a sense of security for the population.

Climate Change

- Hydrogen production from RE sources would make it possible to reduce polluting gas emissions, thus helping to improve the quality of the atmosphere, water and oceans.

Draft Theory of Change and Impact Pathway

Technical Experts' Group on
Research and Innovation

Situation Analysis

1. SWOT
2. Problems | Causes
3. Context & Stakeholder Analysis
4. Further Details

Roadmap and Impact Pathway

1. SWOT

STRENGTH

- Increasing public support to sustainable development policies (e.g., European Green Deal, Paris Agreement)
- Solid scientific research on climate change, supported on a wide range of data.
- Alignment of the issue of climate change with policies, strategies, goals and conventions set up by regional, national, and international governments and organizations including local governments, UNFCCC, IPCC, SDG and Sendi Framework (SFDRR).
- Catalyst for regional cooperation because of its transboundary impact.
- Facilitate access to regional and international funding possibilities.
- Having trans-sectoral impact, it promotes the concept of sustainable development and resilience in all policies and strategies of economic activities in the society.
- **Advance in Earth Observation operational products:** Several innovative methodologies exploiting EO data benefit to surface soil moisture, crop evapotranspiration, health and stress indicators in the view of improving water uses.

OPPORTUNITIES

- Recognition by the society at large that climate change is a real threat.
- Encourage national, regional and international cooperation in research to identify vulnerabilities and investigate adaption and mitigation measures.
- Partnership with national civil societies and private sector in adaptation and conservation projects.
- Encourage innovation and technology transfer that enhance sustainability and combat climate change.
- Increase resilience of local communities and preserve their bioculture.
- Build countries' knowledge and research capacity and capability in climate change.
- Increased agricultural productivity, improved water quality and use-efficiency.
- Maintain and recognise the need to invest in ecosystems capacity to capture CO2 from atmosphere.
- Meeting the growing demand for food and water requires rationales for designing innovative solutions in agricultural land use planning and practices.
- Designing innovative methodologies for monitoring, characterising and digitally representing spatial structures and connectivity.
- Setting the scene for a regional Long-term Socio Ecosystem Observatory (Health Environment) to better monitor socio- ecosystems to improve the risks and vulnerability monitoring and long-term response to environmental, societal and economic drivers.
- An observatory to gather and disseminate information on the health-related effects of environmental and climate change.
- Climate change is a crucial driving force for the whole economic, political, and social structure in the region.

WEAKNESS

- Insufficient scientific and technical capacity and financial capability in many countries to implement major adaption and conservation projects.
- Insufficient frameworks for an effective cooperation in research, technology and innovation among (Mediterranean) countries.
- Lack of cooperation at the regional and international level (UFM is a recent exception).
- Legal framework to support innovation is lacking in many countries in the Mediterranean region.
- Regional strategies and research in Disaster Risk Reduction still focused on sectoral approaches, not addressing sufficiently complex, systemic and cascading risks and challenges.

THREATS

- Uncertainties in climate change scenarios, which may be wrongly perceived by non-specialists downgrading climate change risks.
- Negative impact on socio-economic parameters including poverty, health risks, migration, loss of traditional knowledge, livelihood deterioration, material damage, and urbanization, food crisis. Responding to these challenges will require better data and improved model projections as well as a better understanding of both the impacts of climate change and the role of governance on future resources.
- Negative impacts on food security in the Mediterranean Region:
  a) Less water quality and quantity for irrigation and other utilisations, i.e., drinking water Low productivity in natural and agricultural ecosystems.
  b) Low productivity in natural and agricultural ecosystems.
  c) Uncontrolled multiplication of pumping boreholes causes groundwater depletions.
- Negative impact on biodiversity:
  a) Loss of species (plant & animal).
  b) Eruption of viruses and diseases or pests.
  c) Soil deterioration including loss of fertility and erosion and desertification.
  d) Dwindling ecosystem services including water, food, aesthetic aspects and medicinal plants, rangeland.
- Reduced capacity to fix CO2 at country level.
- Pollution – warming temperatures and heat waves can potentially increase surface ozone levels.
- Climate Change is associated with a broad spectrum of other changes and human-induced climate change and its impacts will continue for many decades.
- Significant gaps remain in the knowledge base that informs both projections of climate impacts on resources and governance strategies that can build adaptive capacity of socio-ecosystems to climate effects.
- Habitats change creates an opportunity for pathogens to get into new hosts (deforestation for agricultural purposes, livestock farms as a source for spill over of infections from animals to people.)

2. Problems | Causes

A. What are the problem areas?

Impact of climate change on the agricultural sector

Agricultural sector is likely the most climate-vulnerable of all economic sectors.

- Total annual rainfall has been decreasing in many parts of the Mediterranean region, a trend expected to be exacerbated in future climate change scenarios. As a consequence, we will see a decline in available water resources aligned with increased demand. Irrigated agriculture will be under great pressure.
- The increasing frequency and severity of drought episodes and especially the greater inter annual variation in rainfall during the growing season, pose serious threats to rain-fed farming.

Despite the overall decline in precipitation, heavy rainfall events are likely to intensify, increasing the risk of flash floods and of negative impacts on all types of farming practices.

Impact on Water Resources and Water Management

- Fresh water scarcity and increased demand require improved management tools to be put in place. The seasonality of stream flows is likely to change, while water in lakes and reservoirs will decline.
- Water quality aspects (salinity levels, nutrients, heavy metals) are to be specifically monitored.
- Given the high share of water use by agriculture, the sustainable management of water resources will rely on the strategies implemented in the agriculture sector across the Mediterranean Region.

Greenhouse Gases Emission (GHG)

- Energy is a major contributor to GHG emissions. Energy demand is expected to increase in the basin to respond to increasing population and economic activities and to alleviate the impact of climate change through water desalination or air conditioning.
- In 2000, 72% GHG emissions were due to CO2 connected with energy consumption. It is estimated that CO2 consumption in 2025 will be double the amount emitted in 1990. In 2006 the share of South and East Mediterranean Countries (SEMCs) in total emissions generated in the basin was 33% whereas it was for Northern Mediterranean Countries (NMCs) 66%. However, in 2025 share of SEMCs in the total emissions in the basin will match that of NMCs.

Biodiversity

- Ecosystems, through their biodiversity and complex interactions among different species, provide a wide range of services including freshwater purification, pollination, temperature and humidity regulation, soil erosion prevention and nutrient cycling, surface run-off regulation, and providing bio-resources.
- Millennial interaction of local people with Mediterranean ecosystems has shaped their bio culture and sharpened their traditional knowledge.
- Biodiversity is negatively impacted by climate change through scarcity of water, heat waves and occurrence of droughts, flash floods and fire. The impact is exacerbated by anthropogenic activities, by increasing and poorly managed urbanization and land use changes.

Public Health

Climate, along with other environmental changes, has both direct and indirect effects on human health. Direct effects include those caused by higher temperatures, increased UV radiation, droughts and other extreme events such as storms and floods.

- The region with concurrent environmental and socioeconomic stresses is at risk Heat waves, air pollution and this kind of hotspot consists of geographically expanding or sprawling cities, replacing vegetation with surfaces retaining heat. Also, cities with poor quality housing that currently experience an urban heat island effect, and cities that have topography that gives rise to stagnant air masses and summer pollution are at risk.
- Increased ambient temperature and altered patterns of wind and air mass can affect chemistry in the atmosphere. Temperature and the formation of ozone at ground level (photochemical urban smog) are related.

Marine ecosystems

The Mediterranean Sea is a hotspot of biodiversity. It hosts 4% to 18% of the world's known marine species, for 0.8% of the global ocean surface. It is also becoming a hotspot of global change. Increasing water temperatures in Mediterranean lead to changes in species composition and abundance. In general, cold- water species become less abundant or extinct and warm-water species become more abundant, leading to homogenization of the Mediterranean biota with warm-water species.

Coastal ecosystems

Coastal ecosystems at the interface of land and sea, are very exposed to climate and environmental change. Human activities (urbanization) combined with climate and environmental change, provoke coastal erosion due to sea level rise, extreme events, sedimentation decrease, salt intrusion in coastal aquifers and degradation of some habitats (e.g., coastal dunes, coastal cliffs, or coastal terraces). Coastal wetlands are particularly affected (MedECC-2019).

Human security

In the Mediterranean region nearly 40% of the coastline is built up. A third of the population (about 150 million people) lives close to the sea and the infrastructures are often very close to mean sea level, because of limited storm surges and small tidal range. As a consequence, rising sea levels, storm-surges, flooding, erosion and local land subsidence impact harbours, port cities and other coastal infrastructures, as well as wetlands and beaches around the Mediterranean. About 15 mega cities are at risk from flooding due to sea level rise, unless further adaptation is undertaken. Another consequence of climate change and human activities threatening human security is salinization of groundwater resources. Coastal areas suffer from intrusion of salt water and this will increase as sea level rises.

Increased frequency and severity of fires, due to warming and changing land management, especially at the periphery of the inhabited areas87 also represents a significant additional security risk for the Mediterranean population.

With respect to social instability, conflict and migration, human security around the Mediterranean is much dependent on socio-political situation but is also impacted by environmental change. Overall, climate change provokes decrease in available natural or financial resources and thereby tends to exacerbate conflicts.

B. Which are the causes and the underlying knowledge- and capacity related causes?

- Climate change is induced by natural phenomena like volcanic activity and solar activity variability. However, anthropogenic emissions of greenhouse gases, mostly through burning fossil fuels, are acknowledged to be responsible for global warming in the last 50 years (Intergovernmental Panel on Climate Change, IPCC).

- The Mediterranean Basin, lying in the transition between regions dominated by sub-tropical and mid-latitudes atmospheric circulation regimes, has been identified to be particularly sensitive to global warming:
    - The average temperature in the region is 1.4°C higher than the average in preindustrial era, 0.4°C more than the global average. It is expected to increase 2.2°C by 2040 possibly exceeding 3.8°C in 2100.
    - The volume of fresh water is estimated to decrease by 2-15% for a 2ºC warming scenario, putting this among the largest decreases in the world.
    - Drought has been experienced in the region since 1950. In addition, frequent occurrence of heatwaves, known to be amplified during drought spells, pose health risks for vulnerable population. Both impact food security in terms of crop, livestock and fisheries yield, which may not meet demand by increasing population in many parts of the region.
- Warming of the Mediterranean Sea surface is currently estimated at 0.4°C per decade for the period between 1985 and 2006 (+0.3°C per decade for the western basin and +0.5°C per decade for the eastern basin). The Aegean Sea shows maximum change in sea surface temperature during August[16]. The projections for 2100 vary between +1.8°C and +3.5°C in average compared to the period between 1961 and 1990. The Balearic Islands, the northwest Ionian, the Aegean and Levantine Seas have been identified as the regions with maximum increase of sea surface temperature.

3. Context Analysis | Stakeholder Analysis

- SDG indicators implementation (roadmap)
- Public Security
- Participative contribution
    - Mainstreaming environmental priorities through public policies
    - Promoting awareness raising
    - Supplementing Governmental authorities with sustainable policy options
- Moving towards a carbon-neutral society, Paris agreement
- Green deal programme and the environmental transition

4. Further Details

Climate Change Impacts

A systematic approach is needed to document the current situation caused by human activity (The Mediterranean Region under Climate Change 2016) on the linked risks related to usages, practices and social views from climate to industrialisation, urbanisation and transport, usages and practices relating to the quantity and quality of mineral and living resources, biodiversity its functions and its services.

Climate change is associated with more heat waves in the summer and more precipitation that may result in flash floods in winter. The consequences of these changes are felt in increasing demand for water, reduction in water quality, conflict eruption among user groups, damage caused by flash floods and drought and heat waves episodes.

Irrigated agriculture is under pressure to sustain productivity as availability of fresh water for irrigation decreases and use of low-quality wastewater increases. At the same time productivity of rain-fed farming system is low because of poor management practices, high seasonal and inter-annual rainfall high variability, low soil fertility and water holding capacity and increasing frequency

of drought and heat waves especially during the growing season. Although future climate scenarios point towards lower annual precipitation in the Mediterranean region, there are indications that the frequency of very intense rainfall rate events will increase. Their occurrence after drought episodes will contribute to soil degradation, putting further pressure on this activity. Thus, rural poor areas in the Mediterranean are expected to experience in a disproportionately manner, the impact of climate change.

Satisfying the increasing demand for quality drinking water and water for irrigation often involves conflicts between users of groundwater and landowners, or between countries. Floods, which are expected to be more frequent, decreases water availability, as they may provoke damage to water supply systems, insufficient drinking-water supplies and disruption of transport systems.

The condition is worsening due to their inflexible financial ability and low ability to adapt. Their livelihood traditional knowledge is threatened, and they are pushed to poverty stimulating the trend to abandon their farms and migrate to cities.

Agricultural Sector

To combat these negative effects of climate change on agricultural sector, governments should support research and development, encourage technology transfer and innovation to enhance resilience of farming systems. Technology like permaculture, hydroponics, aquaponics and precision agriculture should be introduced and investigated. Efforts to conserve genetic resources of local plants and animals are of prime significance to sustain adaptive and resilient biodiversity in the system. If these efforts are coupled with income diversifying projects in the rural areas, it would curb expansion of urbanization.

This involves the development of integrated modeling-observing tools adapted to the complex characteristics of these regions in order to quantify the impact of agricultural water use on the different reservoirs, to characterize the heterogeneities of landscape mosaics (crop systems, climate, soil, infrastructures ...), to be able to translate this functioning into production indicators (agro-system services). It requires representing the strategies of the farmers according to the environmental and socio-economic context and the regional governance policies. Four specific transversal scientific issues were identified to address this objective.

Biodiversity

Biodiversity is being negatively impacted by human activity,

- Land use and urbanization: land use in most SEMCs was not controlled by guidelines. A condition that leads to fragmented land ownership. Fragmented land, mostly abandoned and deteriorated, is not contributing to agricultural sector output and constitutes a preferable target for urban development. This could increase long-term climate vulnerability by constraining the ability of ecosystems to adapt to changing environment.
- Urbanization is a process that is triggered by social, economic and environmental factors (i.e. fluctuation of rainfall and frequent droughts) and mainly at the expense of agricultural land in the high rain-fed zone and forests. Farmers were forced to move their agricultural activity to marginal land of arid and semi-arid zones that receive less than 200 mm rain/ year. This results in soil degradation and loss of biodiversity. The extent of this process resulted in loss of 33% of productive land. The impact was also manifested in the rangeland where overgrazing and land clearing for the purpose of cultivating barely had damaged the plant cover which harm biodiversity and caused soil erosion.
- Land use change may also increase GHG emissions and decrease CO2 fixation by rangeland and forest ecosystem through intentional man-induced fire to clear land for cultivation, cutting trees for firewood, and rangeland overgrazing.
- The frequency and severity of Forest Fires in the Mediterranean Region are expected to increase in a warmer planet. This puts the already fragile Mediterranean ecosystems under increased pressure, further threatening loss of habitats and biodiversity.

The IPCC report (2013) identified the Mediterranean Basin as one of the most vulnerable areas in the world to global warming. Climate change causes warming in the Basin at a rate 20% faster than the global average, where vulnerability to the change was more obvious in the South and East Countries of the Mediterranean due to some intrinsic characteristics of their natural resource base, and economical demands for ever growing population. Their soil is more arid, water is scarce, their natural resources are over exploited, and their technical capacity and financial capability fall below satisfactory to effect large scale mitigation and adaptation programs.

The drivers of climate change in the region include agriculture intensification, pollution, decreasing precipitation and declining biodiversity. Due to climate change and population growth, irrigation demands in the region are projected to increase between 22-74%. Tourism development and urbanization may increase water pollution.

The average temperature in the region is 1.4°C higher than the average in preindustrial era, 0.4°C more than the global average. It is expected to increase 2.2°C by 2040 possibly exceeding 3.8°C in 2100. Drought had been experienced in the region since 1950. In addition, frequent occurrence of heatwaves poses health risks for vulnerable population. The impact on food security in terms of crop, livestock and fisheries yield would not meet demand by increasing population in the region. This is driven mainly by estimated shortage of fresh water of 15% within 20 years; causing use-conflicts among different sectors within the country and between counties on a limited shared water resource.

Climate change also impacted ecosystems in the area resulting in biodiversity decline as a result of overexploitation of surface and aquifer water, land use change, desertification and pollution.

1. Sea water surface temperature has increased 0.4°C/decade.
2. Sea water surface has risen by 6cm/2 decades.
3. Sea water acidity has significantly increased.

These changes affected negatively indigenous fish species and were favourable for alien fish species.

Climate change is associated with more heat waves in the summer and more intense precipitation that may result in flash floods in winter. Consequences of these changes are felt in increasing demand for water, reduction in water quality, conflict eruption among user groups, damage caused by flash floods and drought and heat waves episodes.

Coastal zone

The Mediterranean coastlines have seen significant growth in terms of population density: over 150 million inhabitants – almost a third of the population of the coastal countries, with rampant urbanization (by 2025, half the Mediterranean coastline will be built-up areas).

Sea level rise is a major challenge for the Mediterranean Sea, where risks related to coastal flooding and shoreline retreat are already a serious concern, and where many human, cultural, industrial and environmental assets are concentrated near the coastlines.

Other challenges are presented by increase sea water acidity and by expected increase of temperature by 0.4 C°/decade.

These changes affect negatively indigenous fish species and are favourable for alien fish species.

Climate Change #1

Roadmap and Impact Pathway

Impact of Water Scarcity and Drought in Rural Areas

1. Specific challenges:

It is projected that precipitation will decrease by 10-20% in 2025 in the Mediterranean basin. This is coupled with increased variability of rainfall timing and intensity. The projected increases in temperature (1.5-3.6°C in 2050) further exacerbate the problem. Both variables will affect total renewable water resources. The reduced surface and aquifer water will negatively impact the livelihood of rural communities who depend on either rainfall for their rain-fed agriculture or on aquifers' and rivers' water extraction for irrigated agriculture

2. SDGs

This roadmap and its impact pathway, are contributing to the following SDGs:

SDG	Comment
	Water scarcity will reduce agricultural output causing poverty and hunger. Food production is strongly dependent on and affects the quality and availability of water, because boosting agricultural production can increase water withdrawals and worsen land and water degradation. Counteracting these potential trade-offs will require sustainable agricultural systems and practices, and enhanced water governance to manage growing and competing demands on water resources.
	Reduced fresh water may increase pollution, diseases, and malnutrition. Moreover, achieving nutrition targets requires access to clean water and sanitation. Health and well-being cannot be achieved without access to a sufficient quantity and quality of food. How the SDG 2 targets related to increasing agricultural production and productivity are implemented, will have a major influence on soil and water quality, land use, and ecosystem health and functioning, which are key environmental determinants of health.
	Diminishing and fluctuation of rainfall jeopardize the rural economy.
	Water aquifer will be over exploited and land will be degraded and fertility will be lost.
	Tackling this issue provides a means to combat climate change.

SDG	Comment
	Less water for irrigation and less rainfall for productive range land will endanger the ecosystem (cutting forest trees for fire wood), cultivating marginal land and overgrazing.

Agriculture, food production and consumption are strongly dependent on energy services; conversely biomass and agricultural waste are potential sources of renewable energy. However, competition over the same resources (land, water) can result in trade-offs between both goals.

3. Research & Innovation Agenda

Technological development and efficiency

The specific topic and technological aspect of the research has to be investigated under components and system point of view. To which specific questions does the technological research respond to?

#1 Investigate methods to enhance and Recharge water aquifer

- Conduct research to establish: methods and sites for recharge purposes.
- Preventing loss from evaporation.
- Water storage in the soil profiles at local sites.
- Develop IoT-based platform architecture that considers several types of services to ensure its replication and adaptability to different crops and locations

#2 Develop techniques for water harvesting at macro and micro levels.

#3 Investigate the potential of using brackish and effluent water in restoration of range land.

#4 Investigate energy efficient strategies for water desalination.

Methodological Approach

The specific topic and technological aspect of the research has to be complemented with a comprehensive approach to the research. How will the research be carried out? Which complementary research responding to some specific research questions will have to be carried out? (e.g: resource assessment, needs analysis, demand side management, market analysis, delivery and management, environmental impact analysis, social and economic impact, etc.)

#1 This pathway needs cooperative teamwork among researchers in the field of civil engineering (water) and hydrology and environmental and water resource management specialists. The joint effort is to locate sites suitable to build reservoir (small dams) for recharging purposes, to develop technologies to facilitate soil permeability in these locations, and to assess local environmental impacts.

#2 This research calls for cooperation among hydrologists, agriculturist (horticulture, agronomy, range land and water specialists: To develop techniques to harvest water and plants at the field and individual plant (shrubs).

#3 This research needs cooperation among Agriculturists (range land specialists) soil chemists, ecologists.

#4 This topic needs cooperation among researchers in civil and mechanical engineering and water specialists.

Health Scenario and link with Policy

To understand the long-term impact of the pathway it is also crucial to realise the placement of the technology within the national strategies. In order to go in this direction, the research need to respond to some further issues:

#1 Enhancement and Recharge of aquifer water.

- **Sustain natural resources, enhance aesthetic aspects, improved water management.**

#2 Increase agricultural output (food security).

#3 Protect biodiversity.

Desired Impact Pathway

Output

- Increase aquifer water and raises the water table.

Outcome

- Enhance water quality and availability.

Impact

- Enhance food security and sustain natural resources.

4. Capacity Building Agenda

General Capacity Building Objectives

Please refer to the Knowledge Triangle (research education and innovation) and highlight how the capacity building component matches the research one to enable further, long lasting innovation.

Capacities required	Possible CB Activities and Formats	Outputs	Outcomes	Impact
For Researchers • Funding possibilities. • Networking and cooperate at local and regional levels.	**For Researchers** • Training for proper research proposal writing. • Virtual and physical meetings, information exchange, training possibility.	**For Researchers** • Drafting good quality research proposal for funding with definite variables.	**For Researchers** • Development of team work agenda with regard to the challenge.	**For Researchers** • Increase the country capacity to deal with the challenge.
For Entrepreneurs • Communicating the investment chances available for entrepreneurs alone or with collaborating with government (Private Public Sector Partnership) (PPP).	**For Entrepreneurs** • Workshops and educational seminars about possibilities available for investment.	**For Entrepreneurs** • Raise the awareness of private sector.	**For Entrepreneurs** • Possible private sector involvement in investment opportunities.	**For Entrepreneurs** • Sustainable economic and livelihood of rural population.
For NGO Officers • Education and Training for NGO to better transfer the technology to rural population.	**For NGO Officers** • Workshops and educational seminars for NGO about the techniques developed from research.	**For NGO Officers** • Active and productive NGO effort to help adopt the new technology.	**For NGO Officers** • New Technology adopted by farmers in the rural areas.	**For NGO Officers** • Increase agricultural output and stabilize rural income.
For Policy Makers Draft policies to establish a. Funding platform for research and innovation. b. Incentives to induce private sector to participate in water development sector. **c.** Adopt strategy and action plan to sustain natural resources.	**For Policy Makers** • Educate policy makers about the importance of sustainable use of water resources.	**For Policy Makers** • Available funding for research and innovation • Encouragement investment of private sector	**For Policy Makers** • strategy and action plan for water resource sustainability	**For Policy Makers** • Provision of favourable environment for research and investment in water resource development.

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5. Relation of the research and capacity agendas to …

Health

- Water resource management research will enhance the water quality, reduce pollution and eliminate waste and save water for food production.

Renewable Energies

- Harvesting and managing surface water and enriching aquifer water to raise water table will save energy that otherwise will be wasted in extracting water from deeper water level.

Climate Change #2

Roadmap and Impact Pathway

Sustainable Agricultural Production

1. Specific challenges:

Climate change in the Mediterranean is reflected by elevated temperature, fluctuated precipitation with regard to duration, intensity timing, spatial distribution and extreme climatic events including heat waves and occurrence of droughts in the summer and flash floods in the winter. These variables are expected to impact agricultural production in the Mediterranean basin, because they reduce surface water (35% reduction in SEMCs), increase irrigation requirement for crops, affect crop distribution, may cause occurrence of pests and diseases and change in the land use induced by soil degradation through recurrence of drought, floods, water pollution and depletion of soil nutrients.

Rainfed agriculture, occupies most of the arable land in the South -East Mediterranean Countries (SEMCs) will particularly suffer under these stress conditions. This is important since agriculture is the main income for smallholders (not less than 20% of total population).

2. SDGs

This roadmap and its impact pathway are contributing to the following SDGs:

SDG	Comment
	Sustainable agricultural production and productivity will help in building resiliency of the poor and vulnerable rural areas.
	Sustainable agricultural production will provide nutrients and achieve reasonable level of food security.
	Sustainable agricultural production will reduce water and soil pollution and intrants uses.
	Sustainable agricultural production will help in improving water quality by reducing pollutants and by increasing water-use efficiency.
	Sustainable agriculture through adoption of technological upgrading is expected to sustain economic productivity of rural areas.
	Sustainable agriculture can enhance technology development, research and innovation.

SDG	Comment
	Agriculture sector seems to be the most vulnerable sector to climate change; sustainable agricultural practices will confer high level of resiliency to the sector.
	Sustainable agriculture employs sustainable use of fresh water.
	Sustainable agriculture needs strong relevant national institutions, including through national and international cooperation for building research capacity in the country.
	It enhances international support for implementing effective capacity building to implement sustainable development

3. Research & Innovation Agenda

Technological development and efficiency

The specific topic and technological aspect of the research has to be investigated under components and system point of view. To which specific questions does the technological research respond to?

#1 Introduce new sustainable agricultural systems i.e. aquaponic, hydroponic, aeroponic coupled with using geothermal heating and cooling systems

- This research will respond to the need for increasing production, saving fresh water, reducing GHG emissions.

#2 Investigate management-based adaptation and measures

- breeding for drought and salt resistant cultivars using water-serving-cropping methods (mulching, minimum tillage, crop covers, change in planting dates, and change in cultivars). This research responds to the need for increasing production, preventing soil erosion, saving water and adaptation to drought.

Methodological Approach

The specific topic and technological aspect of the research has to be complemented with a comprehensive approach to the research. How will the research be carried out? Which complementary research responding to some specific research questions will have to be carries out? (E.g.: resource assessment, needs analysis, demand side management, market analysis, delivery and management, environmental impact analysis, social and economic impact, etc.)

#1 This topic needs cooperation among scientists in horticulture soil chemists and experts in fisheries.

#2 This topic needs cooperation among horticulturists, plant breeders, agronomists.

 # Integrated AquaPonic systems for improving food production sustainability and brackish water use and recycling

Health Scenario and link with Policy

To understand the long-term impact of the pathway it is also crucial to realise the placement of the technology within the national strategies. In order to go in this direction, the research need to respond to some further issues:

#1 These new production systems will save fresh water, reduce pollution, and sustain natural resources specially if coupled with using geothermal heating or cooling, and contribute to food security.

#2 These technologies will save water, prevent soil erosion and maintain soil fertility and contribute to food security.

#3 Agro-businesses, farms and civil society develop a strategy for sustainable food systems to drive healthier, plant-based diets.

Desired Impact Pathway

Output

- Increase agriculture production.

Outcome

- Save fresh water.

Impact

- Contribute to food security and sustainable natural resources.

4. Capacity Building Agenda

General Capacity Building Objectives

Please refer to the Knowledge Triangle (research education and innovation) and highlight how the capacity building component matches the research one to enable further, long lasting innovation.

Capacities required	Possible CB Activities and Formats	Outputs	Outcomes	Impact
For Researchers • Funding mechanism. • Framework for cooperation or networking among scientists locally and internationally.	**For Researchers** • Training for proper research writing. • Venues for information exchange (i.e. workshops, conferences, meetings)	**For Researchers** • Research proposals	**For Researchers** • Formation of research groups to investigate the challenge	**For Researchers** • Increase the country's capacity to deal with the challenge
For Entrepreneurs • Communicating feasibility studies for investment in sustainable agriculture	**For Entrepreneurs** • Workshops, seminars, and monographs illustrating possibilities and profit available in investing in sustainable agriculture	**For Entrepreneurs** • Awareness of private sector of the investment opportunities in sustainable agriculture	**For Entrepreneurs** • Possible private sector involvement in sustainable agriculture development.	**For Entrepreneurs** • Sustainable economic, environmental and livelihood of rural population and contribution to food security
For NGO Officers • Education of NGO about the environmental and economic impact of sustainable agriculture.	**For NGO Officers** • Workshops and educational seminars about sustainable development.	**For NGO Officers** • Active and effective endeavour to transfer the technology to small holders including women.	**For NGO Officers** • New technology and agricultural production adopted by farmers in rural areas.	**For NGO Officers** • Increase agricultural output, stabilize income of rural communities.
For Policy Makers • Establish Funding mechanism for research in sustainable agriculture. • Employ Incentive mechanism for farmers private sector to invest in sustainable agriculture, inter alia developing a scheme for private public sector partnership.	**For Policy Makers** • Available studies and other means to educate policy makers about the importance of sustainable agriculture.	**For Policy Makers** • Available funding for research enhancement of private sector involvement. • Incentive plans to encourage investment.	**For Policy Makers** • Adoption of sustainable agriculture by farmers and private sectors.	**For Policy Makers** • Provision of favourable environment for environmental, research and investment in sustainable agriculture.

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5. Relation of the research and capacity agendas to …

Health

- Sustainable agriculture will use less fresh water and minimize soil degradation, pollution and provide nutrients and contribute to food security.

Renewable Energies

- Sustainable agriculture upon using geothermal heating and cooling systems and suitable structure will cut on using energy and reduce GHGs emissions.

Climate Change #3

Roadmap and Impact Pathway

Biodiversity in Changing Climate

1. Specific challenges:

The Mediterranean basin is considered one of the most biodiversity hot spot in the world. Out of 6000 taxa assessed at least 20% are threatened with extinction.

The average regional air temperature in the basin is expected to increase by 2.2°C in this century, in contrast with the Paris agreement target of 1.5°C. The temperature increase may even reach an average of 5.1°C by 2100. Sea level rise at the rate of 5mm/year, temperature and acidity are expected to speed changes in marine ecosystems. The invasion of tropical species, especially in the Eastern Mediterranean Sea, is likely to continue, further stressing local species and an overall biodiversity decline with the loss of commercially relevant species of fish and shellfish is to be expected.

Over land, the increasing aridity associated with rainfall decline and warming temperatures together with increased risk of wildfires will negatively impact both natural and managed ecosystems. The effect of warming has a direct effect on the thermoregulation and indirect effect on the ecosystem productivity and food availability. Within 20 years fresh water decreased by 15% due to projected decrease in precipitation by -4% to -27%. The combined effect of rising temperature and decreased rainfall accompanied with occurrence of intense extreme climate events along with the current pledged greenhouse gases emissions reduction may push half of plant species and third to half of other species to brink of extinction.

Under these climatic changes already, stressed ecosystems will be overexploited specially in poverty-stricken areas. Anthropogenic activities such as overfishing, overgrazing, nonstable agriculture, land use change cause soil erosion, loss of fertility, salinization and pollution, land abandonment and eventual desertification. Farmers are then obliged to move to marginalized fragile land or migrate to cities with consequent encroachment of urban settlements at the expense of productive land or forests.

2. SDGs

This roadmap and its impact pathway are contributing to the following SDGs:

SDG	Comment
	Healthy ecosystem with functional biodiversity will provide services that enhance resilience of poor rural communities vulnerable to climate change.
	Maintaining biodiversity translates into maintaining genetic diversity of seeds, local cultivated plants and domesticated animals and their related wild species.

SDG	Comment
	Vital biodiversity entails less pollution and hazardous contaminants.
	Healthy biodiversity necessitates water-use efficiency, sustainable withdrawals and supply of fresh water and protection or restoration of water-related ecosystems.
	Maintaining healthy biodiversity translates into efficient resource consumption and efforts to decouple economic growth from environmental degradation.
	Scientific research enhancement, technological capability upgrading and innovation encouragement are prerequisites for sustainable biodiversity.
	Sustainable human settlement and curbing urbanization will help in maintaining sustainable biodiversity.
	Sustainable management and efficient use of natural resources contribute to functional biodiversity.
	Improving education, awareness-raising and institutional capacity on climate change mitigation, adaptation and reduction have a positive bearing to maintain biodiversity.
	Addressing the issue of sea water, elevated temperature and acidity is a must to sustain marine biodiversity.
	Conservation, restoration and sustainable use of inland waterbodies and terrestrial ecosystems need functional and maintained biodiversity.

3. Research & Innovation Agenda

Technological development and efficiency

The specific topic and technological aspect of the research has to be investigated under components and system point of view. To which specific questions does the technological research respond to?

#1 Building resilient rural communities:

- Appropriate technology development and transfer are a prerequisite for generating extra income
- Research on food technology including local product development and preservation.

- Develop a cooperative and agro-industrial fabric; this will sustain biodiversity by alleviating poverty and curbing urbanization by sustaining rural settlement and prevent migration.

 # 2 Investigate climate change adaptation and mitigation measures:

- Afforestation and range land restoration.
- Fire-breaks
- Investigate the possibility of creating protected areas in biodiversity not locales.
- No expansion of new agricultural land at the expense of natural ecosystems, integrating 10% biodiversity
- conservation into existing croplands, for biodiversity conservation.
- Monitoring from space provides real time deforestation**,**

#3 Germplasm collection:

- Identification, collection and maintenance of local germplasm and domestic animals. This contributes to save indigenous germplasm and knowledge.

Methodological Approach

The specific topic and technological aspect of the research has to be complemented with a comprehensive approach to the research. How will the research be carried out? Which complementary research responding to some specific research questions will have to be carries out? (E.g: resource assessment, needs analysis, demand side management, market analysis, delivery and management, environmental impact analysis, social and economic impact, etc.)

 # 1 This challenge needs extensive, socio-economic studies and research on food technology and nutrition.

 # 2 This challenge needs cooperative work among agronomist, range land specialist, ecologists and conservation scientists and forestry technologists.

#3 This challenge needs research in botany, zoology, horticulture, agronomy and animal production specialists.

Health Scenario and link with Policy

To understand the long-term impact of the pathway it is also crucial to realise the placement of the technology within the national strategies. In order to go in this direction, the research need to respond to some further issues:

#1 This topic will alleviate poverty and contribute to well-being rural inhabitants.

#2 This Roadmap topic will impact the biodiversity positively by enhancing the ecosystem to fix CO2 and as such help in reducing warming trend and increase the ecosystem efficiency in providing vital services.

#3 This topic is vital to maintain indigenous germplasm that may be used in breeding programs for further strengthening food security and to safeguard local knowledge regarding medicinal plants and their use.

Desired Impact Pathway

Output

- New product development, climate adaptation and mitigation measures, germplasm banks.
- develop and apply innovative methodologies to increase the social-ecological water use efficiency
- managed ecosystems in the face of drier and more extremes climates.

Outcome

- Innovation, biodiversity maintenance.

Impact

- Food security, poverty alleviation sustainable human settlement.

4. Capacity Building Agenda

General Capacity Building Objectives

Please refer to the Knowledge Triangle (research education and innovation) and highlight how the capacity building component matches the research one to enable further, long lasting innovation

Capacities required	Possible CB Activities and Formats	Outputs	Outcomes	Impact
For Researchers • Funding mechanism. • Networking among scientists locally, regionally and internationally.	**For Researchers** • Training for proper research writing. • Meetings, workshops, and conferences for sharing ideas and information	**For Researchers** • Research proposal	**For Researchers** • Research group to investigate biodiversity aspects.	**For Researchers** • Increase the country's capacity in biodiversity research.
For Entrepreneurs • Communication of investment opportunities within the biodiversity niche.	**For Entrepreneurs** • Workshops, seminars and monographs illustrating technological aspects for development.	**For Entrepreneurs** • Awareness of private sector of the investment opportunities available in sustainable biodiversity.	**For Entrepreneurs** • Private sector involvement in research and development and innovation and product development.	**For Entrepreneurs** • Improvement of socio-economic and livelihood of rural areas.
For NGO Officers • Education of NGO about biodiversity significance role in maintaining sustainable services.	**For NGO Officers** • Workshops and training.	**For NGO Officers** • Involvement of NGO in transferring information to stakeholders	**For NGO Officers** • New concepts and innovative thinking and new product development.	**For NGO Officers** • Enhance socio-economic stability
For Policy Makers • Establish funding mechanism for supporting research development and innovation. • Create incentive mechanism to encourage local communities to adopt new technologies and private sector to get involved in R&D and innovation.	**For Policy Makers** • Studies and other means of education about the role and significance of biodiversity in maintaining the livelihood of communities.	**For Policy Makers** • Available funding for research development and innovation incentive plans for investment.	**For Policy Makers** • Adoption of the research and development findings. • Innovative product development	**For Policy Makers** • Favourable environment for research, development and innovation.

References

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- Jana Verdura, Cristina Linares, Eric Ballesteros, Rafel Coma, Maria Uriz and Nathaniel Bensoussan 2019: Biodiversity loss in Mediterranean ecosystem due to an extreme warming event unveils the role of an engineering gorgonian species. Nature. Scientific reports. Article 5911.

5. Relation of the research and capacity agendas to …

Health

- Healthy and Functional biodiversity entails provision of sustainable ecosystem services and minimize pollution and fix CO2 from the atmosphere.

Renewable Energies

- Photovoltaic units to generate electricity could be used to operate agro-industrial industries in the rural areas.

Horizontal Integration & Priorities for a Future Crisis Management Concept

Technical Experts' Group on
Research and Innovation

1. **Recommendations towards the horizontal integration of the three priority areas in the UfM Region**

2. **Priority areas for R&I in the UfM region for a future crisis management concept**

1. Recommendations towards the horizontal integration of the three priority areas in the UfM Region

The priority areas, based on the situation analysis, are linked to each other as follows:

	Health	Renewable Energies	Climate Change
Health		Even though the links between health and renewable energies could be felt to be indirect, there are tight links and mutual influences between these two priority areas. Smart cities based on sustainable and "healthy" sources of energy (RE) will strengthen the health system. Low-carbon strategy and lifestyle lead to both short and medium-long term impacts: • Facilitate resilient, sustainable and safe health infrastructure and facilities that can rely on continuous and stable energy access (short term impact) • Promote healthier populations (medium-long impact)	**Clear link between CC and health with:** **I- Direct links:** • (i) Epidemiological risk related to new emerging and re-emerging infectious diseases • (ii) Increase in the prevalence of chronic diseases (including mental health) and their complications (NCDs directly linked to CC and others already existing that are exacerbated by the CC) • (iii) heat stress *(increased vulnerabilities, conflicts, migration and related health impact)*. **II- Indirect links:** • Food insecurity and malnutrition, water insecurity, injuries, fatalities due to vulnerable shelters, settlements, extreme climatic events **Based on I and II:** • Increase in inequities and vulnerability among the Mediterranean populations and associated risk of population displacement and migration.
Renewable Energies	• A harmonized database platform that could integrate data from health facilities/infrastructure enforces an efficient energy management policy, that necessarily has important social impacts, also in terms of the management of health risks on all scales (buildings, villages, cities, etc). • The need of accessible drinkable water, more productive crops and of reliable facilities for the maintenance of vaccines, stimulate a stable and reliable clean energy production and management.		An effective policy to mitigate climate change is necessarily based on energy efficiency strategies, advanced technologies and on an accelerated RE transition (replacement of the use of fossil sources versus low carbon technologies). • Increasing the share of renewables in the energy matrix 2 • reducing global energy demand through energy efficiency
Climate Change	Managing the energy mix thanks to advanced ICT technology (artificial intelligence and satellite monitoring) could attenuate the problems of variability of renewable energies and therefore increase its share, this will surely contribute to reducing the rate of gases harmful to human health in the atmosphere, and will so improve air quality and therefore the health of the population in both shores of the Mediterranean	Reducing greenhouse gases by encouraging the use of REs and green fuel (H2) would prevent the increase in the temperature of the globe and therefore all the resulting problems responsible for climate change	

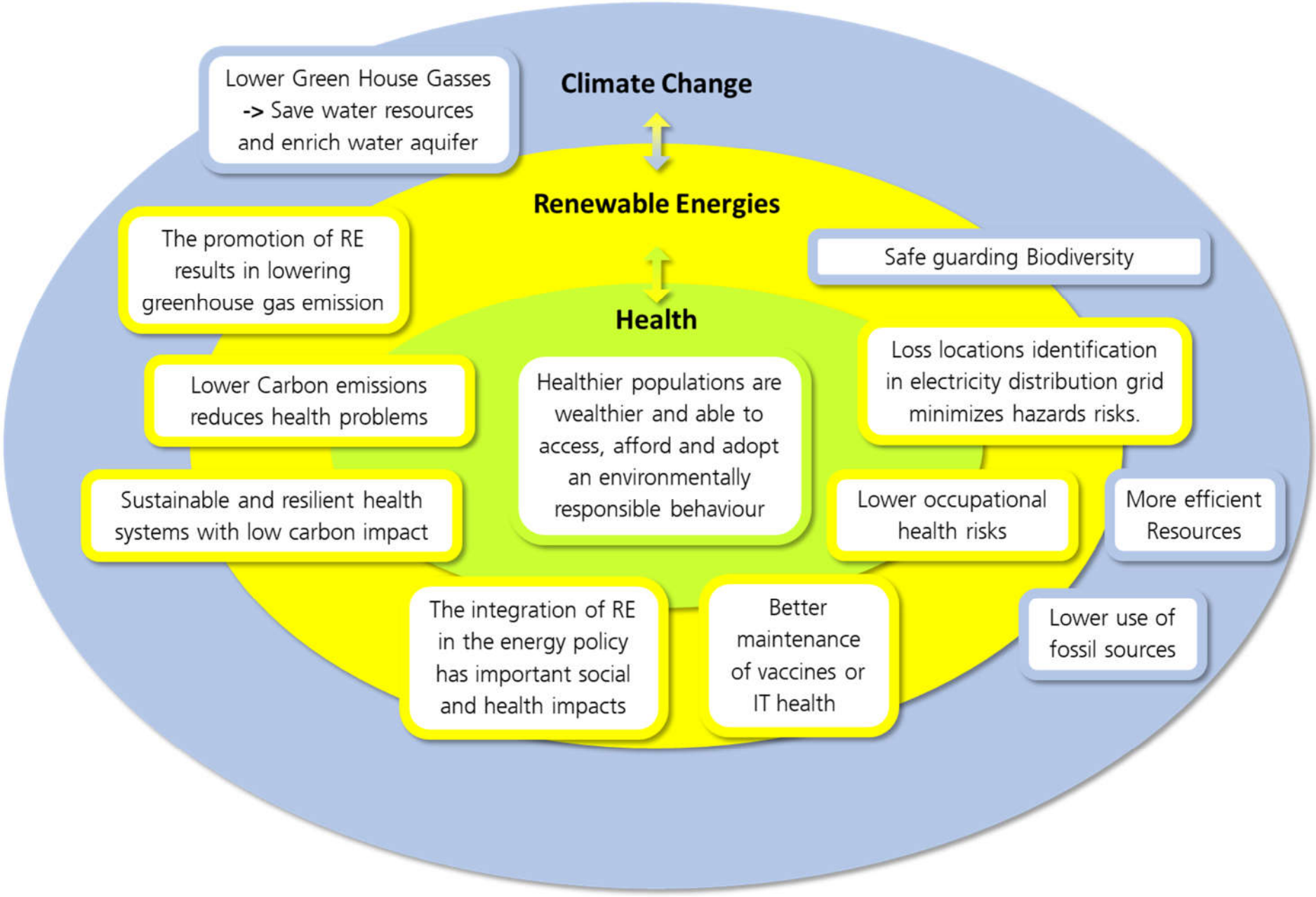

Figure 1: Illustration for the interlinkages between the three priority areas (not exhaustive)

A Theory of Change and Impact Pathway with its roadmaps with real transformation capacity should face the central challenges Europe as a continent also have and integrate or take advantage of the Mediterranean region in this endeavour and do not think on countries in the South -East shore as external to this concept. The Mediterranean basin and the surrounding countries have some shared problems (climate change, environmental degradation, atmospheric pollution, emerging infectious diseases threats), as well as singularities that magnify the divide between the South-East and the North shores, between EU and northern African countries (education, health and social inequalities, technology, access to safe water…). To exert transformative change, actions taken on the three key areas (Health, Climate Change and Environment, and Renewable Energies), should be approached in a way that they bridge the political, economic and legal divide between what it is Europe and what it is not.

While truly integrative actions on all fronts are encouraged by these Expert Panel, the committee is well aware that the EU and national legislation will go against this integration, therefore a number of high-level actions are proposed that bear the capacity to exert change. All other approaches, while important and in the appropriate direction, will at most have limited impact towards the real transformation of the socioeconomic, educational and RDI landscape in the Mediterranean region.

Europe has important challenges from which at least a number of those have its highest expression also in the Mediterranean region, and they are also the centrepiece of these Theories of Change and Impact Pathways, namely Health, Climate Change and Renewable Energies. We propose that one of the centres of investments for the advancement in science and technology and capacity building be located in the Med countries. The Mediterranean Sea countries face extreme environmental degradation due to an aggressive urban growth policy and the limited protection of natural environments, aggravated by the ongoing climate change crisis. As also one of the main hotspots for climate change on Earth, the Mediterranean region (both North and South) will face an escalade in the impacts at all levels of society, environment but also economy, and clear action should be taken immediately to begin adapting to those changes and mitigate harsh impacts. The former will inevitably have a large and negative effect on health and economy at all levels and sectors in our population. To partially remedy this inevitable outcome, massive investment on Research, Development and Innovation (RDI) and capacity building must be executed and the Mediterranean area is an optimal testbed for all those transformative initiatives.

Proposed actions

The region would benefit from the establishment of a program towards the implementation of ‘EuroMed Joint-Research Centers’ on the 3 key areas (Health, Climate Change, Environment and Renewable Energies), also starting from already existing partnership platforms in the frame of Euro-Mediterranean cooperation. These EuroMed JRC would have a bi-cephalic *brotherhood* structure with one physical headquarter in the Northern countries and another in the South. The partnership would include two head offices that would be similar in structure and funding and be the bridge to the EU on the one side and the Northern African countries on the other. Circulation of resources, scientists, technologist and projects would be common and *free* under a same and unique umbrella, so that mechanisms are to be put in place to facilitate this effective movement. Access to EU RDI Programs would be allowed for these centers on an equal basis as if those were made from within Member States (*gateways to the future*). Similarly, specific technological and innovation projects would be initiated and implemented jointly throughout these JRC and without limitations in both the northern and the southern shore, in the same conditions as if they were done by EU member States institutions themselves.

This way a EUMed-JRC on Health, Climate Change or RE would have an interconnected structure that would overcome regulatory and legislation divides between EU and non-EU countries. High-level funding would be specifically allocated so that top-notch RDI would be conducted at these central places to which Universities and research centres (for instance those in the southern shore) could associate to access and participate in all EU mechanisms of research funding. An EUMed-JRC could initiate a Lter-Med initiative (Long-term critical zone observatory for Mediterranean) for the development of a permanent infrastructure for long-term ecosystem, critical zone and socio-ecological research for Mediterranean.

2. Priority areas for R&I in the UfM region for a future crisis management concept

By examining the three situation analyses and the relations between the three priority areas it can be deduced that they are all correlated with each other describe as an 'indivisible whole'. Ending hunger, achieving food security and improved nutrition and promote sustainable agriculture" contains targets with social (e.g. malnutrition and vulnerability), economic (e.g. agricultural productivity and agricultural trade) and environmental dimensions (e.g. genetic diversity and climate resilience) commonly discussed set of interactions lies in the nexus between food, water and energy (Weitz et al., 2014). Water is required in the energy sector for cooling in thermal power plants and for generating hydro-electricity; energy is required for residential and industrial water usage, and for pumping water for irrigation; and water is needed for all food and bioenergy production. In particular, interconnected impact domains between climate change, health and renewable energies in the MC have been identified: water resources, ecosystems, food safety and security, food system, health and human security. Several crosscutting issues should improve collaborative transdisciplinary R&I activities that allow the development of human capital development i.e. fostering sustainability science addressing interactions between natural and social systems, digitalization and use of IA, open science and open data that increases transparency and accelerates sharing of data and results as well as technology transfer, interoperability of transdisciplinary observatories. Although they are characterized by different impacts and expected risks, their combination converges in the path towards healthier societies and sustainable development and innovation promotion.

Therefore, all of the areas for R&I identified by three priority areas represent key priorities for UfM. For the sake of clarity, they are here summarized:

1. Impact of Water Scarcity and Drought in Rural Areas
2. Sustainable Agricultural Production
3. Biodiversity in Changing Climate
4. Improving the health emergency preparedness of UfMC
5. Establishing sustainable and resilient health systems able to answer the needs of the populations, in particular the most vulnerable
6. Overview and modelling of RE scenarios, harmonized RE smart database and communication within UfMC
7. Modernization of the electric power systems (Smart Grid, Smart Cities and local RE generation)
8. Distribution system modernization (Energy Loss Management)
9. Advanced Technologies, Green Hydrogen Production, Storage and Infrastructures implementation

10. Energy -Stability towards stability in Health Systems, Agriculture and Food System and resilience in the context of Climate Change
11. General reliable data-collection, as well as - sharing and -communication for decision making
12. Qualitative data-collection about local (potential) crisis situations and gender specific issues for local interventions towards capacities

To make possible the achievement of the following recommendations and concrete suggestions for action for the partnership in R&I and capacity building, operative research infrastructures/centers/platforms/frameworks have to be established with the requirement of being inclusive with respect to the issues of all the 3 priority areas (Health, Renewable Energies and Climate Change). The operative structure, that could also start from already existing partnership platforms in the frame of Euro-Mediterranean cooperation, by starting first a broader explorative coordination and communication framework, with PRIMA and its structure.

With the following you will find three recommendations and five suggestions for action for the way ahead.

Policy Recommendation 1

Significantly increase the exchange and circulation of knowledge and information in the three priority areas together with the implementation of platforms for facilitating the availability and communication of timely and reliable data also accessible to stakeholders.

Details on the type of action/ intervention needed	• Build up a circular communication platform and mechanism that could engage all the stakeholders by promoting a positive and participated interaction; the same platform should be used also for Monitoring, Evaluation and Learning Activities (MEL) in a metagovernance collaborative and interdisciplinary approach. • Develop a platform for stimulating the share of knowledge towards a RE transition impacting on d Climate Change and consequently on Health • Develop a "knowledge infrastructure" open also to education and communication activities for managing multi-risk/vulnerabilities hazards • Strengthen regional capacities relating to monitoring and analysis of climate change through multilateral exchange agreements data and systems integration climate and systems observation early warning • Create a regional mechanism interface "science - decision" approved by all Contracting Parties to the Barcelona Convention, with a view to prepare scientific assessments consolidated regional guidelines • Enforce innovation processes by means of cooperation between Universities, Companies and local Authorities • Establish appropriate regulatory framework for exchange of data and operationalising open science • Engage all the actors • Life cycle assessment • Innovative portals collecting and integrating a variety of interactive instruments and tools aimed at sustaining technology transfer and knowledge exchange and range • Mapping innovative technologies • Cataloguing innovative opportunities • Promoting matching requirements with technology users to social platforms that attract innovative ideas for SMEs or propose innovative services • Promoting connections between different markets at transnational level.
Links with roadmaps	• **TCIP Renewable Energies | #1 Roadmap** |Overview of RE scenarios, harmonized RE smart database and communication within UfMC • **TCIP Health | #1 Roadmap** | Establish an epidemic preparedness and response EPR Intelligence hub for rapid action coordination among Euro-Mediterranean countries • **TCIP Climate Change #1 and #3 Roadmap** | Establish information platform along the market value chain to furnish data on all production aspects that will help in promoting sustainable food processing and production.
Links with SDGs	SDG3, SDG 7, SDG 11, SGD 12, SDG 13, SDG 17
Links with existing strategies/ initiatives	https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Renewable_energy_statistics https://repo.mel.cgiar.org/handle/20.500.11766/12717
Links with crosscutting issues	• Clusters of cross cutting issues: Transdisciplinary research, Data science, big data and data modelling, Open Science • (1) Digitalization, (2) Open Science, (3) human capital development, (4) Technology transfer and innovation, higher education, (5) Artificial intelligence • Governance • Engagement of citizens • Sustainable development strategy • Data sharing and socio-ecosystem observation system interoperability

Policy Recommendation 2

Promote demonstration TRANSDISCIPLINARY projects on sustainable development in the Euro-Mediterranean Region

Details on the type of action/ intervention needed	• Develop human capital strategies with a trans-disciplinary approach • Fostering sustainability science addressing interactions between natural and social systems • Provide tools and guidance on sustainable development policies, via a knowledge and innovation platform in order to strengthen national governance, legal and investment frameworks and regional cooperation
Links with roadmaps	• **TCIP Renewable Energies | #2 Roadmap** |Modernization of the electric power systems (Smart Grid, Smart Cities and local RE generation, TCIP Renewable Energies | #4 Advanced technologies | Green hydrogen production, storage and infrastructures implementation • **TCIP Health | #2 Roadmap** | Technologies enabling system approach for sustainable and resilient health systems and societies • **TCIP Health | #4 Roadmap** |Smarter cities enabling healthier behaviour • **TCIP Climate Change #1 Roadmap** | Develop appropriate technology to effect development of new products that enhance the socioeconomics and foster the resilience of plural communities.
Links with SDGs	SDG 1, SDG 2, SDG3, SDG 8, SDG 9, SDG 11,
Links with existing strategies/initiatives	• Initiatives of the Scientific and Technological Research Council of Turkey (TUBITAK) • https://prima-med.org/ • https://en.ird.fr/research-issues/sustainability-science
Links with crosscutting issues	• Clusters of cross cutting issues: Transdisciplinary research, Social sciences, Data science, big data and data modelling, Open Science. • (1) Digitalisation, (2) Open Science, (3) Human capital development, (4) Technology Transfer and Innovation, (5) Higher Education, (7) Smart specialisation strategies, (8) Artificial Intelligence, (9) Social Sciences, (10) Eco-Innovation.

Policy Recommendation 3

Promote technology cooperation

Details on the type of action/ intervention needed	• Establishing a network of Euro-Mediterranean observatories, dedicated to monitor the effectiveness of the adopted strategies • Closing the gap in MC between research and applied technology towards a sustainable development • Foster the creation of an LTer-Med (long term critical zone observatory for Mediterranea) • Support for development and testing of new observation technologies and approaches • Set up an integrated information system accessible to the public, through a triumvirate of governments, international organizations and the private sector • In this context, the Southern and Eastern Mediterranean Countries could be at the European core testbed for Renewable Energy tech development and implementation, also for developing carbon-removal strategy and incentives' policies. In order to positively stimulate a collaborative eco-system, scientists from South-East-Mediterranean Region should be allowed to participate in equal conditions as European centres even if their countries do not contribute financially to EU funds. •
Links with roadmaps (*)	• **TCIP Renewable Energies | #1 Roadmap, #2 Roadmap, #3 Roadmap, #4 Roadmap** • **TCIP Health | #2 Roadmap** | Technologies enabling system approach for sustainable and resilient health systems and societies • **TCIP Health | #4 Roadmap** | Smarter cities enabling healthier behaviour • **TCIP Climate Change #2 and #3 Roadmaps** | Technology transfer in sustainable agriculture (hydroponic/aquaponic). Technology transfer in food preservation, processing and product improvement.
Links with SDGs	SDG 1, SDG3, SDG 8, SDG 9, SDG 11
Links with existing strategies/ initiatives	• https://www.lter-europe.net/lter-europe • European Climate and Health Observatory
Links with crosscutting issues	• Clusters of cross cutting issues: Transdisciplinary research, Data science, big data and data modelling, Open Science, • (1) Digitalisation, (2) Open Science, (3) Human capital development, (4) Technology Transfer and Innovation, (5) Higher Education, (7) Smart specialisation strategies, (8) Artificial Intelligence,

Suggested Action 1

Establish a network of greenhouse gases stations for a decarbonization and RE strategy

Establish a network of greenhouse gases (EGE) stations covering the Mediterranean (particularly the *South, but not only, is not at all covered*). To be later integrated for instance in ESFRI programs such as ICOS, T-TORCH, LTER and as GAW/WMO stations.

Suggested Action 2

Establish three joint long-term research centers addressing health, renewable energies, climate change

Establish with EU funds as Joint Research Centers (JRCwAfrica) 3 new longterm infrastructures as Bi-cephalic hubs (NorthSouth) of RDI and Tech-transfer in the 3 areas (Climate, Renewable Energies and Health). Ask the South-East Mediterranean Countries to provide for free as their contribution historical buildings where these RDI infrastructures can be implemented (linking science with Art and cultural heritage).

Suggested Action 3

Establish a Mediterranean climate observatory and an index for climate change and sustainability

Create a Mediterranean Climate Observatory (JRC-type) in the South-East Countries (well-funded and with permanent staff) and an international Mediterranean index for Climate Change and sustainability (with many indicators at country level) and a biennial Med Prize for countries (w funding) to stimulate zero-emission conversion transitions. (Climate Change, ALL)

Suggested Action 4

Establish a regional center for epidemic preparedness and response in Southern Europe

Ask the WHO-EU to create a new regional center for epidemic preparedness and response in Southern Europe. Fund it as a co-located center of the ECDC.

Suggested Action 5

Marie Curie Actions exclusively for North African young scientists

Create a specific section in the Marie Curie Actions exclusively for North African young scientists (postdocs) to apply (at no cost for those countries in the first 10 years). For instance, funding 100 scientists/year on a 2+1 funding scheme (2-year in a center in Europe and 1-yr back in a N. African country). EU centers should receive an incentive. Establish the ulterior obligation by the country of origin of offering a tenure-track contract to the recipient (3year funds) plus stabilization afterwards if evaluation successful.

Suggested Action 6

Establish a North Africa-EU RDI programme in the priority areas

Create a specific programme for centres in Europe and in North Africa to co-apply on an equal basis (1+1) on a specific 3-4 year Horizon Europe project of RDI application/implementation in the Southern shore. European centres would receive an additional stimulus (100k€/year?).

Glossary

AI	Artificial Intelligence
Anthropogenic activities	Activities that are produced or caused by humans (usually has negative correlations).
AU	African Union
AUC	African Union Commission
Biodiversity	The variety of life in all its forms and at all levels from genes to ecosystems including terrestrial and aquatic ecosystem and diversity within species, between species and of ecosystems.
Biodiversity loss	The reduction of any aspect of biological diversity in a particular area which can occur by extinction, destruction or manual removal.
CC	Climate Change
Climate change	As defined in Article 1 of the United Nations Framework Convention on Climate Change: "a change of climate which is attributed directly or indirectly to human activity that alter the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.
Conservation	The protection and management of biodiversity to maintain it at a threshold level.
CSO	Civil Society Organisation
DPO	Data Protection Office
EC	European Comission
EE	Energy Efficiency
EG	Expert Group
EMC	Euro-Mediterranean Countries
EPR Intelligence Hub	Epidemic Preparedness and Response EPR Intelligence Hub
EU	European Union
Extinction	The dying out or extermination of a species. Extinctions can be global or at smaller scales.
GACD	Global Alliance for Chronic Disease GACD
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GloPID-R	Global Research Collaboration For Infectious Diseases Preparedness
H	Health
ICDA	International Common Disease Alliance
IGO	Infertility, Gynecology and Obstetrics
Institution	An established law, custom, usage, practice, organization or other element in the political or social life of a people. More broadly, institutions are the arrangements that govern the collective undertakings.
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
IRB	Institutional Review Board (IRB)
IT	Information Technology
JRC	Joint Research Center
Land use	The human use of a specific area for certain purpose. Land use change refers to a change in the use or management of land by humans.
LCA	Life Cycle Assessment
M&E	Monitoring and evaluation
MC	Mediterranean Countries

MedECC	The Mediterranean Experts on Climate and Environmental Change.
MEL	Monitoring, evaluation and learning
MOOCs	Massive Open Online Course
MSCA	Marie Skłodowska-Curie Actions
NCD	Non-communicable diseases
NGO	Non-Governmantel Organisation
NMC	North Mediterranean Countries
OECD	Organization for Economic Co-operation and Development
PEM	Private electronic market
PIMC Model	Programme and Innovation Management Cycle Model; developed by the LEAp-Agri and LEAP4FNSSA procects
PRIMA	Partnership on Research and Innovation in the Mediterranean Area; An EU funded joint programme to support food systems and water resources in the Mediterranean basin, partner countries, international agreements and latest
R&I	Research and Innovation
RDI	Research, development and innovation
RE	Renewable Energies
Resilience	The magnitude of disturbance that an ecosystem or society can undergo without crossing a threshold to a situation with different structure or outputs (different state). Resilience depends on factors such as ecological dynamics as well as the organizational and institutional capacity to understand, manage and respond to dynamics.
Restoration	Any intentional activities that initiate or accelerate the recovery of an ecosystem from degraded state.
RIA	Research and Innovation Activity
SDG	Sustainable Development Goals
SEMC	South-East Mediterranean Countries
SFDRR	Sendai Framework for Disaster Risk Reduction.
STI	Science Technology and Innovation
Sustainability	A characteristic or state whereby the needs of the present and local population can be met without compromising the ability of future generations or populations to meet their needs.
Sustainable agriculture	Farming in sustainable ways meeting societies present needs without compromising the ability for current or future generations to meet their needs.
SWOT Analysis	Strength, Weaknesses, Opportunities and Threats Analysis
TCIP	Theories of Change and Impact Pathways; A TCIP consists of 1) a situation analysis, 2) roadmaps = agendas for research and innovation and capacity building together with desired impact pathways which are structured along outputs, outcomes and impact; 3) a monitoring, evaluation and learning concept
TDR	Transdisciplinary Research
TRL	Technology Readiness Level
UfM	Union for the Mediterranean
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change.