FONDAZIONE ENI ENRICO MATTEI

FEEM Research Plan

2017-2019

Fondazione Eni Enrico Mattei
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TABLE OF CONTENTS

INTRODUCTION

Objectives

In 2015, FEEM's Board of Directors, with the scientific support of FEEM's Advisory Board, approved a reorganization of FEEM's research activities. This re-organization was designed to achieve five important objectives that can be summarized as follows:

1. *Relevance*. Focusing on relevant (for Eni, the business world and policy institutions) research topics and cross-cutting themes
2. *Impact*. Fully exploiting the existing portfolio of projects and related funds to enhance FEEM's impact (in particular through a revised communication strategy)
3. *Funding.* Further improving FEEM's fund-raising performance
4. *Community.* Increasing integration and collaboration among research programs and special initiatives.
5. *Quality.* Re-balancing the size, contents and quality of the programs and give more opportunities to young talents.

Actions to achieve these objectives have been implemented in 2016. In particular, collaboration among research programs and special initiatives has been achieved through the interaction between research programs and cross-cutting themes as shown by the matrix displayed in Figure 1.

In a subsequent meeting, in February 2016, FEEM's Board of Directors stressed three additional objectives:

- *Innovation.* Enhancing the innovative content of FEEM's research and ability to carry out studies on innovative topics
- *Future challenges.* Focusing on future societal and economic challenges
- *Interdisciplinarity.* Enhancing interdisciplinarity and involvement of stakeholders in FEEM's research activities

Organization

Given their importance and long-term nature, all these objectives still guide the design of FEEM's research plan for the years 2017-2019. Therefore, research will still be organized along both research program and cross-cutting themes. At the same time, research coordinators will be asked to develop more focused and innovative research programs and more interdisciplinary projects.

To this end, cross-cutting themes have been revised. Indeed, the matrix in Figure 1 differs from the one that characterized FEEM's research in 2016 mainly because cross-cutting themes have been updated in the wake of suggestions and recommendations provided by both the Scientific Advisory Board and the Board of Directors. The *Agenda 2030* and *Local Projects for Sustainable Development* still remain important cross-cutting themes.

Three new ones characterize FEEM's research plan for 2017-2019:

- *Pathways to Sustainability in Africa:* this consists of a series of research, studies, events and capacity building initiatives in Africa. These have been designed to give FEEM a role as a think tank providing knowledge production and dissemination on sustainable development in Africa, particularly Sub-Saharan Africa. This cross-cutting theme was discussed at length both by the Scientific Advisory Board and by the Board of Directors and emerges as one of the pillars of FEEM future studies.

- *Climate Change and Migrations:* this is a highly sensitive economic and policy issue. Migrations towards Europe are presently at the heart of the political debate and search for consensus. But worldwide migrations, particularly in developing countries, are an even hotter topic. It is

therefore crucial to understand their link with climate change and how future impacts of steadily accelerating climate change will induce even larger migration phenomena.

- *The Age of Instability:* migrations are not the only relevant issue with the potential to destabilize our societies. Instability and the related uncertainty is a pervasive phenomenon, affecting all dimensions of our societies, from financial markets to food production, from energy sources to the development of cities, from crime and war to health and virus control. A broader perspective on FEEM's traditional sustainability issues would therefore be fruitful.

Innovation

With one exception, the titles of all our research programs remain the same (see again Figure 1), but the contents of the proposed research plan are quite innovative also for our four research programs.

The program focusing on climate adaptation and sustainable development, for example, plans to develop a *spatially defined economic model*, which will give FEEM a lead in the analyzing the impacts of climate change and indicators for assessing SDGs.

As another example, the program focusing on mitigation and innovation plans to further strengthen research on *behavioral economics and agent-based models*, now at the frontier of research in economics. And the program focusing on energy scenarios and policies will develop new research initiatives on *Africa's future energy scenarios*.

A detailed description of the innovative contents of all the research efforts of our programs is provided in the rest of this plan.

One research program has been completely innovated. The Social Innovation and Sustainability Program is now the *Society and Sustainability* program, designed with a broader scope and higher academic standards. The program has a new coordinator and will focus mainly on three areas:

- impacts of climate change on business performance and long-term company strategies
- the sustainability of cities and their future development
- the economics of biodiversity.

Integration

All these research areas partly overlap with the work of the other research programs and thus further stimulate collaboration among FEEM's researchers. In addition, this is likely to give a new boost to important research areas such as sustainability of cities or climate-sensitive company strategies.

Finally, the need for greater *collaboration and integration* among cross-cutting themes has also been carefully taken into account. Therefore, a coordinator will be identified to supervise the work on cross-cutting themes to enhance their interaction with research programs, increase the quality of research and exploit synergies.

Pillars

In addition to new research topics - among them let us stress again the focus on sustainable development in Africa, an issue that has been strongly recommended by the Board of Directors and deeply discussed by the Scientific Advisory Board - there is another important novelty in this new research plan. In order to achieve consistency and comparability with the research plans developed by top universities in Italy, FEEM's activities have been organized along three pillars:

- The first one, *Research*, is FEEM's traditional focus.
- The second one, *Training and Dissemination*, is meant to enhance FEEM's efforts in education. FEEM has already organized training programs and summer schools in the past, but the new research plan is characterized by an enhanced effort to work on human capital capacity building both in Italy and in other regions (Africa in particular).
- The third dimension is called *Third Mission* by Italy's Ministry of Education and Research (the other two missions of a university are obviously research and training) and is newer for FEEM. To better

specify FEEM's activities, the third mission is divided into two components: (i) *Policy relevance and support*, and (ii) *Social impact and business development*.

The *Third Mission* gives a new emphasis to FEEM's research plan. FEEM's research and related activities will be designed to increase FEEM's impact on policy decision processes in Italy and in the EU (the recent agreement with the Ministry of the Environment is an important example) and to promote collaboration with the business world. New initiatives to explore the challenges and impacts for the business world and society in general raised by climate change - and more generally by sustainability issues - will be organized. And efforts to identify how FEEM's research can support business development and new entrepreneurship will be implemented (the success of this year's call for ideas on microfinance is another good example). The focus on its third mission will also enhance FEEM's fund-raising opportunities.

Vision

The vision of FEEM resulting from this new emphasis of FEEM's activities can be summarized as follows:

FEEM is an innovative, policy oriented, research center and think-tank, producing high-quality, interdisciplinary, academic research, scientifically sound and non-partisan policy advice, ideas and tools with relevant social and economic, as well as environmental, impacts.

In addition, FEEM will maintain its focus on a gender-balanced research and administrative staff and on a recruitment policy that is both inter-cultural and international.

Resources

It's important to stress that all research programs identified both new research directions and the resources to achieve their research and policy objectives. The plan has been constructed under the assumption that FEEM's financial resources will remain approximately the same over the next three years, possibly with the addition of funds specifically devoted to the Africa cross-cutting theme, and that FEEM's fund raising success rate will not diminish.

The research plan is organized as follows. Section 1 will describe the planned objectives and initiatives of the four research programs: Mitigation, Innovation and Transformation Pathways (MITP); Climate Change, Economic Impact and Adaptation (EIA); Energy Scenarios and Policy (ESP); Society and Sustainability (SAS). Section 2 will outline a plan for the five cross-cutting themes, whereas section 3 will focus on the activities of the International Center for Climate Governance, the main tool through which FEEM is able to involve the public at large and the policy community.

All research programs have been asked to highlight their contributions to the crossing-cutting themes and to identify priorities in their own research objectives. A table with these priorities and the time distribution of research activities has been produced by each research program and can be found below.

1. RESEARCH PROGRAMS

FEEM's research is organized around four research programs, five cross-cutting themes and a dissemination program called International Center for Climate Governance. The four research programs propose a research strategy that is meant to be both innovative in the academic environment and relevant for the policy and business communities. Several topics and issues addressed by the research programs overlap and therefore require a degree of coordination, to be achieved mostly through the cross-cutting themes, whose objective is to drive and coordinate the programs' research activities on highly relevant and policy focused themes. In this first part of the 2017-2019 research plan, the initiatives and research objectives of the four research programs are described in detail.

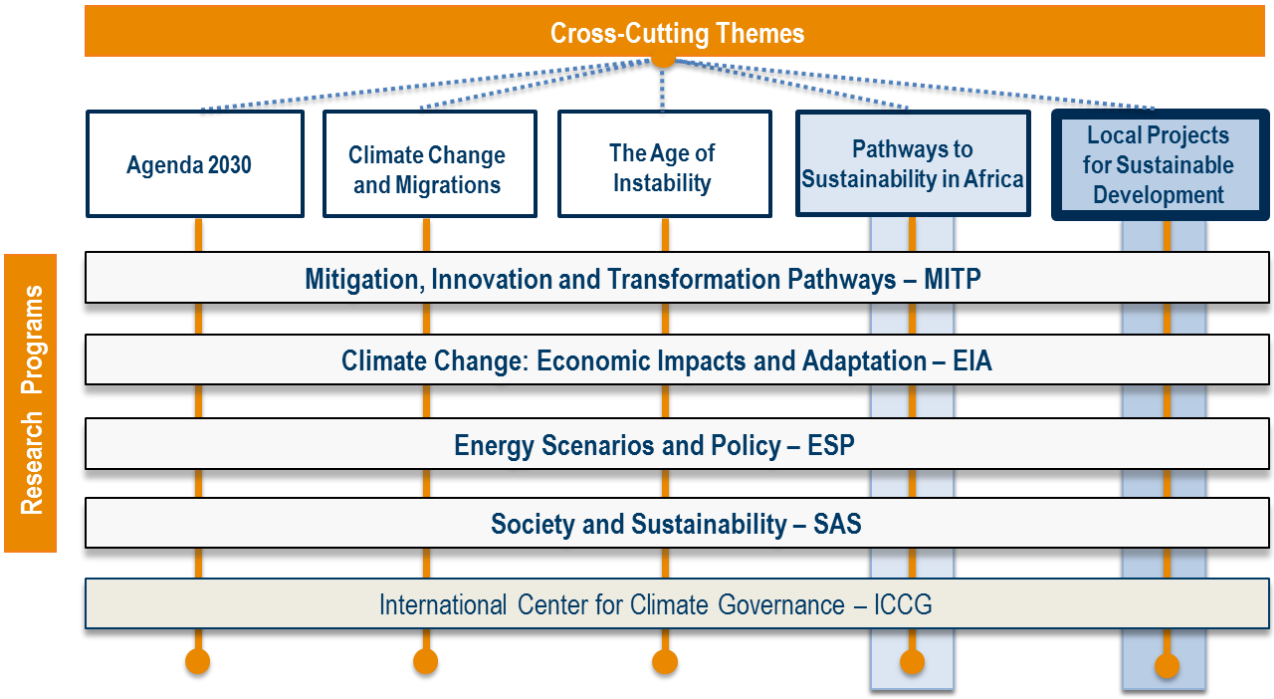

Figure 1: The Structure of FEEM research organization

1.1. Mitigation, Innovation and Transformation Pathways (MITP)

Introduction

The main goal of this research program is to assess and guide the economic transition towards a low carbon world. Climate change mitigation plays a key role, given the fundamental transformation of the economic, energy, land and water sectors required to decarbonize our society and achieve climate stabilization. MITP aims at investigating what strategies and policies are needed to attain a low carbon economy, while considering overall economic efficiency, equity and sustainability. In this respect, MITP focuses on the interactions of different environmental systems with the economy.

MITP is one of the most consolidated research programs at FEEM. It consists of a highly interdisciplinary and international staff of 21 researchers (9 senior, 12 junior). A significant fraction of the research staff (76%) has either obtained a PhD or held post-graduate positions abroad in top-tier institutions (such as the Toulouse School of Economics, the London School of Economics, Princeton University, Stanford University, the University of Luxembourg, the Katholieke Universiteit Leuven, the University of Sussex-Brighton, the University of Geneva, the University of Michigan, Athens University and the Georgia Institute of Technology). Research from MITP has been published in all top-ranked international scientific journals, testifying to the high academic standing of the research program.

Despite the well-established and successful nature of this research program, it remains important to plan ahead and anticipate future trends in research and funding needs.

Research

Short term planning (2017)

In light of the results obtained in the recent past, the short term strategy is that of consolidating the program's outcomes in terms of research excellence. MITP's core research strength lies in the areas of climate change mitigation, innovation and decision making under uncertainty. In 2017 it will therefore be important to maintain a leadership position in Europe and elsewhere on these topics. At the same time, the plan is to further explore the co-linkages between climate change control and other targets among the recently defined sustainable development goals (SDGs). Recently, MITP worked on energy poverty (SDG7), both with analytical and empirical contributions, and is planning to carry out additional field work in developing countries, also thanks to recent funding from the International Growth Center (IGC). MITP is also working on air and water quality (SDG3 and SDG6) with an EU-funded project ('CD-LINKS', in collaboration with the Euro-Mediterranean Center on Climate Change - CMCC) which explicitly focuses on the interplay between climate change and other societal objectives. Within this same framework, MITP plans to focus on economic inequality (SDG10) and climate change. Income inequality both within and across countries is recognized as one of the most pressing social issues, something that climate change impacts as well as mitigation policies could further exacerbate. Thus the need for a joint assessment, which would benefit from a close collaboration with the 'EIA' research program. Another area of collaboration with the EIA program is climate-induced migration, which also has profound implications for the low carbon strategies, given its impact on regional population growth. Within MIPT's modelling activities, we plan to include the representations of migration in the climate change modeling framework, in close collaboration with the 'Migrations' cross-cutting theme.

Long-term planning (2018-2019)

Our long-term strategy is to further consolidate MITP as a key player in the climate change and environmental economics community. In order to achieve this goal, we plan to maintain our research focus on the key areas where MITP currently holds a competitive advantage, namely 'Low carbon transformation', 'Green innovation' and 'Climate risk and uncertainty'. In addition, we plan to strengthen new research areas which are currently under-represented (see Table 2). In particular, we aim at intensifying research efforts in both climate finance (in collaboration with the SAS program) and SDGs (in collaboration with all other research programs). Both are high priority policy areas which have the potential

for high quality publications with a strong interdisciplinary slant, one of the core strengths of MITP's research program. We also plan to significantly expand research in the recently established focus area of 'Smart energy and big data', as clearly shown in Table 2. Thanks to a recently awarded 3 year grant ('PENNY') and to already present research capacity ('ERC COBHAM', in collaboration with CMCC), we plan to carry out innovative research combining the insights of behavioral economics with the increased availability of big energy data and the development of new statistical methods based on machine learning. Combining both strands of research, which so far have been mostly used in isolation, can yield original research of also high practical value, as also discussed below. This stream can benefit with cooperation with the 'ESP' and 'SAS' research programs.

Topic	Main objectives
Low carbon pathways	Assessing the decarbonization pathways compatible with climate stabilization, in terms of transformation of the energy, land use, and economic sectors.
Climate policy	Evaluating different climate policy architectures in terms of effectiveness, efficiency and equity. Assess the stability of international climate agreements.
Sustainable Development Goals (SDGs, in cooperation with EIA)	Assessing the requirements for attaining the main SDGs, such as energy poverty, water quality, education, inequality, climate, migration. Evaluating the interdependencies between the various SDGs.
Green Innovation	Assessing both ex post and ex ant the technological change consistent with climate policies. Identifying policies aimed at fostering green innovation.
Climate risk and uncertainty	Quantifying the risks and deep uncertainties related to both the science and the socio-economics of climate change. Incorporating them into decision-making criteria and improving communication of uncertainties to society.
Smart energy and big data	Analyzing energy consumption patterns from smart meters and other big data devices. Field testing of behavioral interventions aimed at fostering energy efficiency and adoption of new technologies.

Table 1: MITP's main research areas and their objectives

Training and knowledge dissemination

MITP's high quality research has the potential not only to inform the specialized public but also to help train future researchers and policymakers and improve the outreach to the general public. Currently, MITP organizes per year several workshops that are open to the public, co-directs the important 'International Energy Workshop', and has had a leading role in building climate change modeling capacity in developing countries, most notably in Southeast Asia.

Short-term planning (2017)

MITP has been a leading contributor to the 5th assessment of the Intergovernmental Panel on Climate Change (IPCC), both in terms of human capital (3 lead authors, 1 review author) and scenarios. We plan to maintain its presence in the IPCC, given its key role in disseminating scientific findings and reaching out to a broader public. In 2017, the IPCC will be busy with a new special report, requested in the Paris Climate agreement, on the feasibility and impacts of attaining 1.5°C targets. MITP will contribute to the IPCC report with several authors and peer reviewed studies.

Regarding training activities, we plan to host at least one internally funded workshop, co-organize the 2017 International Energy Workshop jointly with the University of Maryland, as well as participate in international forums such as the Stanford University led Energy Model Forum. We also aim at intensifying the training activities of young Master's students. MITP will host 2-3 graduate students who will collaborate with the modeling research team in writing their Master's theses. Thanks to the collaboration with universities in Milan (most notably Bocconi and Politecnico di Milano) MITP can help train students in topics and skills which are rarely taught in the curricula of Italian universities.

Long-term planning (2018-2019)

In the longer term, we aim at maintaining our leadership position in the IPCC, in particular in the planned 6th assessment report. We also plan to contribute to similar international forums, such the IIASA led 'The World in 2050', and the Princeton University led 'International Panel on Social Progress (IPSP)'. Participation in such international reports would enable us to provide a broad dissemination of MITP research.

In addition, we plan to expand capacity-building activities in developing countries. The Paris agreement has institutionalized a new process based on a bottom up architecture of national commitments, whereby all countries have set emission reduction targets for 2030. However, most countries lack the analytical and modeling capacity needed to plan the transition to a low carbon society. MITP can help governments and research institutions in developing countries by training officials on energy and economy planning tools to help them design a robust and efficient policy strategy. One geographical area of particular relevance is that of Africa, where MITP could collaborate with the 'Pathways to Sustainability in Africa' cross-cutting theme.

Third mission: policy relevance and support

A significant fraction of research carried out at MITP can have a direct impact on the policy process. This is especially true for international climate policy, where the research on low carbon transformation has been taken up by policymakers from national governments and international organizations. For example, MITP, together with EIA, has recently advised the economist's office of the Asian Development Bank on low carbon pathways in Southeast Asia. Similar consulting has been done for the World Bank, the UK Government and the OECD.

Short-term planning (2017)

Our short-term priority is to maintain the focus on climate policy and climate pathways, as shown in Table 2. The 'Intended Nationally Determined Contributions (INDCs)' of the Paris agreement have been finalized, but their assessment in terms of climate effectiveness, economic efficiency and equity impacts remains limited. Using the tools and skills available at MITP to help evaluate and confront the INDCs is an obvious policy priority. The Italian government is also busy assessing the burden-sharing of the EU's 2030 energy and climate strategy, and the implementation strategy of the ambitious new plan. MITP will provide analytical background work to help confront policy choices.

Long-term planning (2018-2019)

Thinking about the long term, the Paris agreement has set a policy process of bottom up policy proposal and top down supervision, which naturally demands policy input of a quantitative nature. Countries are required to periodically update their commitments, with the goal of ratcheting up the level of ambition. MITP can help guide the policy process by means of its economy-energy-climate planning tools and policy expertise. As indicated in Table 2, one area where we think there is significant potential for expanding the policy focus is that of innovation and technical change. The EU in particular has set new ambitious climate goals, and has emphasized the importance of economic competitiveness and job creation, but has so far done little to promote effective innovation. Yet technological change is a key ingredient for ensuring that the goal of low-cost climate stabilization is reached, and to promote the economy of Europe. MITP's econometric skills, along with its modeling of technical progress, can generate precious insights for

designing effective policy tools, especially in the EU. Thanks also to a recently funded project (via CMCC), we plan to expand the focus on green innovation policy. Last but not least, we hope to guide policymakers on communicating climate change uncertainties. Climate risks and uncertainties are profound and are often misunderstood in policy circles. With the help of the insights of behavioral economics and social psychology, we aim to formally test how uncertainty can be most effectively communicated to policy makers.

Third mission: social impact and business development

Social impact and entrepreneurship development have not been particularly high priorities for MITP, as shown in Table 2. This is due to the traditional focus on research, which involves an altogether different set of skills. With that said, MITP has developed over the past years a set of online tools aimed at disseminating research in an accessible and informative way for the society at large. The element of either social or business impact is also the core of the EU's H2020 framework program, and thus demands increasing attention for funding purposes.

Short-term planning (2017)

In the short term, we plan to significantly expand the online tools with which we communicate research to our stakeholders. We are planning a community-wide effort to develop an integrated set of web applications which can target different users (public, policy, business), can be rapidly updated, and makes use of innovative visualization which makes it possible to handle different levels of complexity. We also plan to support business development by advising both the public and corporate sectors on strategies for emission reduction, which can provide an important additional lever to the nationally determined INDCs. For example, pairing up with local municipalities or companies such as Eni or business councils such the WBCSD would make it possible to translate research results into actionable strategies.

Long term planning (2018-2019)

As clearly shown in Table 2, one area where we believe there is significant potential is that of 'Smart energy and big data'. The development and penetration of smart sensors which can help consumers as well firms to track energy and emissions opens up new possibilities for bringing MITP knowledge to the market. For example, over the next two years all smart electric meters in Italy (the first country to introduce such devices) will be upgraded, and the total EU market is expected to embrace almost 200 million users. This will generate a wealth of high frequency energy consumption data which can be analyzed by means of modern statistical tools from machine learning and big data. Translating this wealth of information into actions which are profitable for individuals and firms requires specific knowledge of energy and climate markets, as well insights from the behavioral sciences to overcome the known adoption barriers.

MITP can in principle successfully develop applications, algorithms and communication tools to turn the raw data which will be generated by smart meters into valuable information. A spin-off company which works with energy utilities, product developers or retailers by providing high skill products could be established, also thanks to seed funding available from the EU for environmental start-ups.

Resource requirements

In order to implement the planning outlined above, the research program will need to invest in both personnel and methodologies.

MITP can currently count on an international team with a high diversity of different skills. The team size is probably sufficient for the delineated activities, but MITP will have to successfully handle a traditionally high turnover. High turnover is quite common in research institutions which are globally exposed, but is particularly acute at FEEM because of its relatively flat organization and its historical inability to provide permanent positions. Recent changes in the availability of tenured positions can change this situation, and a formal process of promotions will need to be established.

MITP has developed in-house tools which have generated significant results and rose funding over the years. Implementing the proposed plan will require continued updating of current tools, but also development of new ones. In particular, we plan to develop new modeling tools - for example, agent based ones - to model innovation processes and help embed the empirical work in the models. We also envisage skill-building in machine-learning statistical processes to help model energy consumption patterns.

Sources of funding

Funding for MITP has traditionally come from internal sources and most importantly third-party financing, such as the EU framework programs. These will remain the key sources of funding in the medium term, but uncertainties abound in relation to their size and long-term viability. MITP's large international team will require significant resources to continue to work at required levels. We plan to integrate the traditional sources of funding with new ones. In particular, a feasible strategy might be to target organizations and governments involved in the climate action strategies in developing countries, in order to help implement the INDCs. The business development related to the smart energy and big data area can also provide additional revenues from the traditionally untapped private market.

Collaboration with cross-cutting themes

As already anticipated, MITP plans to collaborate with all the cross-cutting themes on key topics. For example, MITP will use the research developed in the migrations cross-cutting theme to help improve the dynamics of demographics in the major world economies. Population is a major driver of emissions, and climate-induced migration can have a significant impact on regional population. Moreover, migrations can have important repercussions for economic growth and innovation, two key factors in the mitigating climate change.

In addition, MITP will collaborate with the Africa cross-cutting theme to help delineate mitigation strategies for African countries. It will also collaborate on the topic of energy poverty, where MITP is carrying out original field work to assess incentives aimed at fostering energy efficiency and adopting clean technologies such as cooking stoves.

Given that one of the core areas of MITP is that of the SDGs and their interaction, there are obvious interactions and collaborations on the Agenda 2030 cross-cutting theme. In particular, MITP will provide analytical assessment of the synergies and trade-offs involved in achieving the main SDGs in 2030.

Finally, climate change can have impacts on the world economy that are catastrophic, difficult to predict and prone to exacerbating political and economic instability. The research area on uncertainty and risk will collaborate with this cross-cutting theme to help quantify the risks and impacts of extreme events and catastrophic climate change.

Overview chart

Topics	Research			Training and dissemination			Policy support			Social impact and business		
	2016	2017	2018 2019	2016	2017	2018 2019	2016	2017	2018 2019	2016	2017	2018 2019
Decarbonization strategies												
Climate policy												
Climate finance												
Co-linkages (air quality, water, land etc.)												
Green Innovation												
Climate risk and uncertainty												
Smart energy and big data												

Table 2: MITP's sum up of the priority areas over time (Orange=High; Blue=Medium)

1.2. Economic Impacts and Adaptation to Climate Change (EIA)

Introduction

Research on the economic assessment of climate change impacts and adaptation policies, now conducted by the Economic Impact and Adaptation (EIA) research program, has been a cornerstone of FEEM's research activity for the past 16 years. It has fostered the development of a multiplicity of investigation approaches: econometric techniques, application of macro-economic dynamic optimization and computable general equilibrium models, geo-referenced vulnerability mapping, and indicator-based analyses of sustainable development. It has also stimulated a highly multidisciplinary research which has enabled FEEM to establish connections with many national and international research institutions beyond the social sciences, ranging from climatology to oceanography and the natural sciences.

In the field of economic assessment of climate change impacts and adaptation, FEEM has built an authoritative role as forerunner and innovator whether in terms of methodology or of anticipating relevant policy issues. At the start of the new millennium, FEEM was among the first research organizations to tailor and apply computable general equilibrium (CGE) modelling to the study of the economic consequences of climate change, estimating the indirect economic effects and the role of market-driven-adaptation. In this respect the work that FEEM has developed to quantify impacts on ecosystem services with CGE models remains particularly innovative. FEEM was also the first research organization to initiate research on the relationship between adaptation and mitigation under a dynamic optimization framework characterizing respective trade-off and complementarities. Another recent strand of research is the application of FEEM's CGE model to develop an indicator-based study of sustainable development and of how policies affect sustainability. Unlike the vast majority of existing studies, FEEM's methodology makes it possible to carry out an ex ante, and not only ex post, analysis of sustainability and to capture the relationships across its economic, environmental, and social dimension. In parallel, FEEM has developed a solid expertise to address climate change impacts with a more micro and local perspective. This strand of research, which uses spatially resolved physical impact data and mapping techniques, has focused on water and disaster risk management, especially as related to flood events, and, in the last year, to the study of urban vulnerability and adaptation.

EIA research has produced a number of publications in high-level amply referenced academic journals, among others, in IPCC's Fourth and Fifth Assessments Reports. These publications have allowed FEEM to establish important research partnerships with leading institutions beyond academia, such as the OECD, the European Investment Bank, the Asian Development Bank, and the World Bank. Thanks to its developed models, FEEM is now a consultant/advisor of the Italian Ministry of the Environment (MATTM) and the Italian Environmental Protection Agency (ISPRA).

In the light of this success, EIA proposes to continue and strengthen its core research areas (namely: economic assessment of climate change impacts and adaptation policies, links between climate change and Sustainable Development Goals, water and disaster risk management), and to introduce some new research topics, as described below. The overall objective remains:

(a) consolidating FEEM's position as forerunner and academic innovator in the research environment;

(b) strengthening FEEM's role as authoritative policy advisor at the international, national and local levels;

(c) increasing FEEM's ability to dialog and work with local stakeholders and businesses, especially in the Italy;

(d) last but not least, strengthening the collaboration and better exploiting synergies across FEEM's different research areas.

Research

The first highly innovative research development proposed by EIA, which also offers a *trait-d'union* across the different research domains of its research program, consists in pushing the macro-economic assessment of climate change impacts and adaptation policies to a high spatial resolution, i.e. at the "cell" level, with a 100 - 50 km2 or even finer granularity.

This research, allowing strong synergies with the SAS program, bridges the existing and unresolved gap between the present macroeconomic integrated assessments of climate change and the more local analyses: the former conducted with "aggregated" global economic models, which account for economic interactions and feedback but are typically unable to refine the analysis beyond the country dimension, and the latter often using highly resolved input information from process-impact models (such as land use models, crop models, sea-level rise models etc.), which are unable to capture feedback from the macroeconomic context.

Addressing this mismatch, especially in the analysis of adaptation, is a top priority for research on integrated climate change assessment, and so far it has not been tackled satisfactorily. The endeavor is particularly challenging, but also a step forward with respect to existing knowledge. In particular, the planned research will integrate macro-economic modelling, statistical econometric downscaling techniques, spatially resolved climatic, climate impact and socio-economic data, supercomputing power to produce economic vulnerability and risk maps in different scenarios, economic sectors, countries and regions within them.

This effort paves the way to enriching other EIA research fields with new innovative content. In particular:

- EIA will keep on developing its model/indicator-based analyses of sustainability and of policies for accomplishing Sustainable Development Goals for 2030, but with novel features. The analysis will be improved to enable FEEM's CGE model to better represent the social "pillar" of sustainability to include aspects such as inequality, unemployment and, in the light of the development discussed above, to provide sub-national sustainability analyses highlighting regional disparities. These aspects are absolutely new to research in the field.

- The analysis of adaptation policies will be pushed to a higher granularity, making it possible to deal with local adaptation measures. In parallel, when entering a new area, EIA will strengthen its research on the urban dimension of climate change impacts and adaptation in collaboration with SAS. With two-thirds of the world's population expected to become urbanized by 2050, cities will rapidly be not only one of the major sources of CO2 emissions, but also hot spots of climatic vulnerability where climate change adaptation will face its greatest challenges. This study field is a booming area, in which FEEM's involvement is of strategic importance.

- By benefiting from the integration of macro-economic impact assessment and spatially detailed vulnerability analyses, EIA will develop a "bottom-up" research on (a) opportunities for and development of natural disaster and natural hazard insurance, and (b) development of nature-based and ecosystem-based solutions for disaster risk reduction and, more generally, climate-change adaptation.

These two themes are innovative and scarcely explored by the literature. This gap is particularly pronounced in Italy, which, compared to other EU countries, lags behind in addressing these topics and activating concrete initiatives in relation to them.

Topic	Main objectives
High resolution economic assessment of climate change impacts and adaptation policies	Developing climate change vulnerability, risk and adaptation analyses through substantial integration of climatic, process and macroeconomic models, at a scale able to address the needs of local policy makers, communities and businesses.
Model/indicator-based analysis of SDGs and sustainability for 2030 (jointly with MITP)	Assessing the requirements for attaining the main SDGs, such as energy poverty, water quality, education, inequality, climate and migration. Evaluating the interdependencies between the various SDGs and policies
Impacts and adaptation at the urban level	Increasing knowledge of the dynamics of climate change impacts and adaptation at the urban level, developing a methodology to address those impacts, fostering the development of a research community on the topic, and educating urban policy makers on mainstreaming climate change adaptation in urban planning.
Nature and ecosystem-based solutions for disaster risk reduction	Identifying the cost and effectiveness of nature and ecosystem-based solutions for disaster risk reduction and climate-change adaptation, defining adoption/implementation strategies, exploring the possibility of developing natural disaster and natural hazard insurance in the Italian context.

Table 3: EIA's main research areas and their objectives

Training and knowledge dissemination

EIA is already involved in several training and dissemination activities and will continue with most of them. EIA provides high-level training/education to the PhD program in Science and Management of Climate Change of the Ca' Foscari University of Venice, specifically in its course on economic modelling of climate change impacts and adaptation, which is taught by EIA staff. In addition, it is involved in the selection process of PhD candidates, thus offering an important opportunity to identify valuable researchers interested in EIA topics, with the potential to subsequently join EIA staff.

EIA plans to strengthen the role of EIA researchers and senior researchers as supervisors of Marie Skłodowska-Curie fellows and further incentivize junior EIA researchers to apply to exchange research programs supported by international scholarships such as Marie Skłodowska-Curie or AXA. These are all valuable opportunities to ensure the progress of EIA research, and train and select a high-profile staff.

Most importantly, within the next three years EIA will organize a summer school focused on climate change adaptation and will collaborate on organizing a training program dedicated to building the capacity of policy makers and scholars in African countries to grapple with issues of sustainable development, sustainable development policies and their assessment. This activity will be developed in cooperation with the "Pathways to Sustainability in Africa" cross-cutting theme.

Finally, EIA will launch a pilot program of seminars dedicated to Italian high school students, presenting the major themes related to climate change science impacts and policies and/or sustainable development, and promoting pro-environment, sustainability behaviors. This activity will be developed in cooperation with all the other FEEM research programs, in particular MITP and the "Agenda 2030" cross-cutting theme.

Third mission: policy relevance and support

All the research strands that EIA intends to develop are not only scientifically innovative but also tackle highly relevant policy issues. They will strengthen FEEM's policy visibility and strengthen its relationships with international, national and local policy environments.

At the heart of "Agenda 2030" are its Sustainable Development Goals (SDGs), which clearly point the way to accomplishment. International and national policy makers need instruments and analyses to assess costs and effectiveness of pro-sustainability policies by interpreting the complex interactions between the different pillars and goals defining sustainable development. The analysis of SDGs that EIA will conduct with its CGE model will provide just this guidance and offer quantitative support for implementing the Agenda, measuring trade off and complementarities across policies and objectives at a global, national and regional scale. In this respect FEEM can usefully contribute to the activity of the UN's Sustainable Development Solution Network (SDSN) of which FEEM is already the host institution for SDSN Italy, but it can also analyze sustainability at the more local scale.

Adaptation to climate change is increasingly strategic. Its importance has lately been stressed by the outcome of the 2015 Paris COP 21, where almost all the Nationally Determined Contributions of Developing Countries included specific adaptation goals. Furthermore, in the EU, after the completion of National Adaptation Strategies to climate change, the EU countries, Italy in particular, are currently defining their National Adaptation Plans, meant to operationalize the Strategies and offer practical guidance, but also to set deadlines for local planners to mainstream adaptation in their health, landscape, coastal protection and disaster prevention programs. In the next few years, local administrations in the developed and developing countries will thus increasingly need support to quantify the local vulnerabilities and risks posed by climate change, cost and effectiveness of adaptation measures, and effective strategies for their implementation. Shifting the emphasis of climate change impact and adaptation assessment at the "local" and urban levels by fusing together macroeconomic analyses and spatially explicit information, answers this need. In particular, green infrastructures, re-naturing of cities and ecosystem-based solutions are the new keywords in the study of adaptation at the center of EIA research interest. All this will multiply the opportunities to conduct applied research, and, in particular, will contribute to strengthening the links between FEEM and Italy's local contexts, communities and administrations.

Actual natural hazard insurance in Italy does not account for the likely impacts of climate change. These impacts could become potentially very severe and require the joint presence of both public and private actors, including re-insurance companies for an adequate risk sharing. Failing to build an adequate "mixed" system can dramatically increase the climate vulnerability of the exposed communities and stress the insurance sector, while, on the contrary, an efficient insurance can strategically contribute to smoothing out climate change costs. The following questions thus become extremely policy relevant: How to efficiently design this system? How to integrate the action of public and private actors? How to implement it? What are the potential costs and benefits? EIA will address these questions and facilitate the process of building such a system. A first intermediate step will be to initiate a Partnership for natural hazard risk assessment involving major Italian institutions, including the Civil Protection Department, ISPRA, CREA, ANIA and CIMA. The partnership can be built on the example of the UK's Natural Hazard Partnership and the Climate Partnership.

Third mission: social impact and business development

EIA activities can generate social impacts and entrepreneurship development through the training courses that can contribute to the adaptive capacity, in the face of climate change, to build and promote pro-sustainability behaviors. Both can generate new business ideas and development opportunities.

The work on insurance will alleviate the societal vulnerability to climate change and stimulate new forms of public-private partnerships, while working with local administrations and communities to estimate the effects of climate change, co-design and implement effective adaptation strategies will reduce its adverse consequences.

The social impacts of all these actions will be maximized if included as support to the activities of those FEEM cross-cutting themes such as Pathways to Sustainability in Africa or Local Projects for Sustainable Development, which are more directly oriented to promote social impacts.

Collaboration with cross-cutting themes

The evolution devised for EIA research is naturally suited to give support to, complement, and interact with the research activities developed within FEEM's various transversal areas. Specifically, EIA can support country analyses with analyses of climate change impact, adaptation and, more generally, sustainable development policy, conducted both with a macro-economic modelling and from a local, "project based" perspective, to include the active involvement of stakeholders and local communities.

In this context, vulnerabilities, challenges to development and potential solutions will be investigated and identified in collaboration with local stakeholders, policy makers and experts in order to offer effective and practical solutions. EIA can finally contribute with training activities on climate change impacts, adaptation and sustainability addressed both to scholars and administrators. This activity can target both developing countries/communities and the Italian context.

The research developed by EIA tackles one of the major sources of instability in our time: climatic change. It can thus usefully complement the analysis of the "financial side" or "geopolitical" instability and of those mechanisms that can transfer and amplify tensions from one domain to the other.

The indicator based analysis of policies toward for achieving SDGs and the Agenda 2030 that EIA carries out jointly with MITP is perfectly suited to complement quantitatively, and be complemented by, ex-ante and ex-post analyses of the Agenda 2030 conducted with more qualitative-social-policy approaches and from a micro-oriented perspective.

EIA can support research by cross-cutting themes with socio-economic information to characterize future scenarios of development and quantify the additional pressures on economic variables (e.g. GDP, prices) with high-resolution climate and impact data on resources (e.g. energy, water, food) and the demand and supply triggered by climate change.

Resource requirements

In order to implement the planning outlined above, the EIA research program will need to invest in both personnel and methodologies.

Human capital

The EIA research team is probably sufficient for the delineated activities, as long as there is the capacity to maintain the current staff. In this respect, it is worth highlighting that skills in spatial analysis and data management have been acquired through collaboration and joint research development with PhD students partly supported by their scholarships. It would now become important to offer an opportunity to these researchers to stay and carry forward their research activity at FEEM.

Methods and tools

EIA has developed and continues to develop both macroeconomic models and spatially resolved techniques for the economic assessment of climate change impacts and policies. The challenge is to put these two methodologies together and to further integrate these with high resolution climate change and physical impact data. This will require developing new interfacing and downscaling methodologies for constructing and managing huge volumes of interconnected climatic, environmental and economic data, and applying ad hoc analytical methods for their analysis. To do so it will be crucial to exploit collaborations with institutions that possess super computers with huge data storage capacity, and skills in big data management.

Sources of funding

EIA's core funding comes from the EU framework programs, even though there has been an increasing effort to differentiate the funding sources by turning to international institutions such as the World Bank, the European Investment Bank and, more recently, the Asian Development Bank. These alternative funding sources could become essential in the light of the increasing competitiveness and aleatory nature of EU funding. The EIA is thus tightening its links with these potential donors by exploiting its recognized expertise in development policies related to climate change impacts and adaptation. Furthermore, to improve its capacity to conduct regional/spatial analyses, the EIA could access new funding opportunities within and outside the Italy by supporting vulnerability-risk reduction and resilience improvement. In this regard, the interfacing with businesses increasingly interested in climate services for preventing and managing climate risk can be particularly fruitful.

Overview chart

Topics	Research			Training and dissemination			Policy support			Social impact and business		
	2016	2017	2018 2019	2016	2017	2018 2019	2016	2017	2018 2019	2016	2017	2018 2019
High resolution economic assessment of climate change impacts and adaptation policies												
Sustainable Development Goals (SDGs)												
Impacts and adaptation at the urban level												
Nature and ecosystem-based solutions for disaster risk reduction												
Climate change risk assessment, prevention and management in businesses												

Table 4: EIA's summary of the priority areas over time (Orange=High; Blu=Medium)

1.3. Energy Scenarios and Policy (ESP)

Introduction

The energy sector is experiencing an unprecedented period of profound change as technological, geopolitical and economic pressures rapidly converge to reshape conventional, decades-long paradigms.

The energy revolution in North America has completely reshaped the global oil and gas markets, apparently paving the way for a new era of abundance of hydrocarbon resources. At the same time, rapid technological innovations and innovative public policy choices have triggered an unprecedented development of renewable energies. Europe has firmly committed itself to decarbonization. Furthermore, with the COP-21 process, the world has embarked on a new phase of decarbonization with unprecedented ambitiousness not only among developed countries but also among emerging economies. On the geopolitical side, major challenges have emerged, from the EU-Russia geopolitical standoff over the Ukraine to the rapid expansion of the Islamic State in key MENA energy-producing countries. Further, the current global economic downturn has hit the energy sector with an unprecedented drop in energy demand, in especially in Europe.

This complex and challenging situation requires an innovative approach capable of combining the major factors (e.g. technology, economics, geopolitics and social) driving the changes in global energy. In particular, a wide range of issues, from demand to supply, from infrastructure needs to their financing aspects, from market analyses to their socio-economic impacts, will be explored under their economic, geopolitical and institutional perspectives. The ESP Program will be developed along the lines of this kind of comprehensive and inclusive approach, combining quantitative and qualitative analyses. In this context, the ESP program will seek to closely cooperate with FEEM's other research programs.

The aim of the ESP Program is to carry out applied research that is scientifically sound, prospective and policy-oriented, to be targeted at political and industrial decision makers. Considering In the framework of FEEM's leading research role in Italy, this new approach to energy issues will be applied to selected regions of the world, which might be considered as the most strategically relevant for FEEM and for Italy's future foreign relations in terms of energy, economics and politics.

The ESP Program will be structured along three main research lines: 1) The Future of European Energy Markets; 2) Towards a New Euro-Mediterranean Energy Roadmap; 3) For a Sustainable Energy Transition in Sub-Saharan Africa.

Research

The Future of European Energy Markets

These are highly interesting and challenging times for the European energy industry. Different drivers of change are rapidly converging to reshape the traditional structure of the European energy market, opening up new challenges and opportunities for the future.

In this framework, the line of research will provide an in-depth comprehensive and integrated analysis of European energy markets, structured on three key pillars: a) The European energy transition: challenges and opportunities; b) New avenues for European energy infrastructure financing; c) Towards a new EU architecture for security of gas supply.

The European Energy Transition: Challenges and Opportunities

Decarbonization represents the cornerstone of EU's energy and climate policy architecture. On the basis of the long-term vision of an 80-95% reduction of greenhouse gas (GHG) emissions by 2050 with respect to 1990 levels, the EU has adopted the binding target of a 40% reduction of GHG emissions by 2030 with respect to 1990 levels. To achieve this target, the share of renewable energy in the EU electricity generation mix should rise from the current level of 25% to a level of 45% in 2030. This increase will be

largely met by variable renewables, such as wind and solar. This will require profound changes in power system operation, market design, infrastructure development and transformation of conventional generation mix.

More flexibility will be required in the system, in order to reduce the intermittency of variable renewables and ensure the overall stability of the system. The technical and economic issues related to the integration of variable renewables into the system will be analyzed.

The vast potential for energy efficiency and demand side management in Europe will also be analyzed not only for its potential but also for the measures required to exploit it.

Decarbonization implies renewables and energy efficiency, but it also implies switching away from the most polluting component of the energy mix: coal. In this framework, the role of gas as a transition fuel will be analyzed in terms of both competitiveness and system security.

New avenues for financing European energy infrastructure

The energy transition will require massive investments in Europe. Market forces and public policies will be necessary in order to cope with these vast investments. An appropriate market design should first of all be in place to facilitate decarbonization. Furthermore, new models of financing that combine public and private funds alongside existing tools might also be needed.

The bulk of the investments required for the transformation of the European energy system should come from the private sector, particularly through a market-based approach. However, public institutions could potentially facilitate and foster private investments. Recent experiences have, for instance, shown that strategic trans-European energy infrastructure projects defined by European authorities to increase overall EU energy security do not always match the commercial priorities of private investors.

In this framework it is particularly important to explore new avenues for financing European energy infrastructure. A key focus should be the role that institutional investors (i.e. pension funds, mutual funds, sovereign wealth funds) might play in the field, also with the support of new investment vehicles being formulated by the European Commission (i.e. the so-called "Junker Fund") and the European Investment Bank.

Towards a new EU architecture for assuring gas supply

Gas will play a key role in the EU energy system for decades to come. Even in strong decarbonization scenarios that assume a potential decrease in future gas demand, the EU gas import requirements will most likely continue to grow in the future, if for no other reason than rapidly decreasing domestic production. In this framework, security of gas supply will remain a major issue for Europe.

A critical, realistic assessment of the EU's future gas strategy and its implementation options in the aftermath of the Ukraine crisis will be provided. Furthermore, an in-depth assessment of the future evolution of the EU's domestic conventional and unconventional supply potential, as well as the supply potential and strategies of Russia, Norway, Algeria, the Caspian, the Middle Eastern and Eastern Mediterranean regions and different LNG supplies to Europe will be carried out. Russia, Europe's largest gas supplier, is presently redefining its strategy towards Europe and will certainly continue in the future to be a very important supplier, though possibly with a different strategic priority. Depending on the evolution of the overall EU-Russia geopolitical relations, different cooperation scenarios in the field of energy, and more specifically gas, between Russia and Europe can be identified. Notwithstanding its primary role in the EU gas market, the future prospects of Norwegian gas production and exports are little explored in the existing literature. This is particularly surprising, as the future Norwegian exports to Europe are generally taken for granted even if Norway will need to find significant new gas fields in order to maintain its output at today's level after 2020. A different analysis needs to be applied to Algeria, a country which presents a more comfortable reserve level but which faces potential production problems in some of its major existing fields. Moreover, Algeria is still relatively underexplored in terms of both conventional and unconventional gas resources. The key problem in Algeria relates to governance constraints, which actually hinder the development of gas resource potential. As for the Caspian and Middle Eastern regions, an accurate analysis

of the future prospects of the Southern Gas Corridor will be provided. With the recent discoveries of gas fields in offshore Egypt, the prospects of an East Med gas hub will be analyzed from both the economic and geopolitical perspectives. Finally, since LNG might represent the most important supply diversification option for Europe, the research project will analyze the future prospects of this market, which includes in the longer-term a contribution from sub-Saharan Africa to Europe. In particular, the role of LNG in Europe will be assessed in both under its external (i.e. global market dynamics) and internal (i.e. Europe's gas interconnections) dimensions. Acquiring a better and more realistic understanding of Europe's diversification options and potential is a precondition for developing Europe's future energy and gas strategies.

Towards a New Euro-Mediterranean Energy Roadmap

The so-called "Arab Spring" has opened a new era of uncertainty for the Euro-Mediterranean area. Specifically, in the current transition phase the Southern and Eastern Mediterranean region urgently needs to find a new path for strong and sustainable socio-economic development. If we consider its macroeconomic and energy fundamentals, the region has a great potential for triggering a new development process, and the ongoing political changes can enhance such a new dynamic.

Today Southern and Eastern Mediterranean countries (SEMCs) face a range of pressing socio-economic challenges which include solving the problems of poverty and large structural unemployment, in the context of rapid demographic growth. Energy is an essential commodity enabling socio-economic development, and for this reason an enhanced cooperation effort of the EU in the Mediterranean region should primarily target this sector. In particular, three pillars can be outlined: a) Enhancing hydrocarbon cooperation; b) Supporting a sustainable energy transition in the region; c) Financing of Mediterranean energy projects. The integrated analysis of these research pillars aimed at designing a full-fledged energy roadmap for the region constitutes an original contribution to the existing research activities in the sector. Such a comprehensive cooperation scheme would contribute to increasing prosperity in the region, opening markets, ensuring access to resources, increasing exports and investments, and promoting sustainable global growth. It would also contribute to establishing a wider area of stability and peace.

Ensuring hydrocarbon cooperation in the region

This research pillar will provide an in-depth analysis of the current and prospective Mediterranean oil and gas trends, drivers, policies and partnerships, with the aim of developing a win-win Euro-Mediterranean oil and gas strategy capable of tackling the barriers that are currently limiting the regional oil and gas sectors, with the target of promoting simultaneously local development and further exports to Europe. Such an exercise seems to be particularly important in light of the new "European Energy Security Strategy" published by the European Commission in May 2014. This strategy calls for an enhanced diversification of EU energy supplies, and it clearly targets the Mediterranean region as a crucial contributor to this strategy. This research pillar will assess the potential of conventional and unconventional oil and gas production in North Africa and the Eastern Mediterranean for its reserve and resource availability as well as for the institutional, governance and commercial attractiveness of the region. The Mediterranean region is not only important in terms of hydrocarbon production but also in terms of transit, as the cases of Egypt and Turkey clearly indicate. The Mediterranean is strategically located at the crossroads of existing and potential hydrocarbon flows from the Middle East and Africa to Europe, making it an important transit corridor for global energy markets.

Supporting a sustainable energy transition in the region

The current energy situation in SEMCs is characterized by a rapid increase of energy demand, low energy efficiency, and artificially low domestic energy prices stemming from schemes for extensive universal consumption subsidies. All country finances are under the strong pressure of increased investments in new energy facilities as well as supporting costly universal energy subsidies. In short, the current energy situation does not appear sustainable and poses several risks to the prospects of socio-economic development of the region. In this area, the research pillar will mainly focus on the following issues: assessment of the evolution of domestic energy demand, with a special focus on electricity demand and

supply, energy efficiency, renewable energy and the energy-water nexus. The research pillar will primarily analyze the fundamentals of SEMCs' domestic energy market developments by using a scenario approach that combines quantitative and qualitative analyses, with a particular focus on the trends of the electricity sector (e.g. supply, demand, infrastructure and markets). Energy efficiency is a key element for a sustainable energy transition in the region. This research pillar will explore the role the EU could play in supporting developing energy efficiency measures in SEMCs, focusing particularly on technical assistance programs and dedicated financing mechanisms. Technical assistance programs could easily transfer best practices on energy efficiency, especially in regard to standards and labelling of appliances, equipment, buildings and vehicles. With regard to renewable energy, solar and wind energy continue to cover less than 1% of SEMCs' electricity generation mix: a figure strongly at odds with the region's abundant solar and wind resources. The research pillar will explore the reasons for this paradox, focusing especially on the key barriers to developing renewable energy in the region: the extensive use of energy subsidies and the lack of adequate electricity infrastructures, energy regulatory frameworks and financing mechanisms. Intra-SEMCs and SEMCs-EU electricity interconnections are needed to create larger, integrated and more efficient, regional energy markets. On the basis of this in-depth analysis, the project will formulate a comprehensive, innovative, pragmatic, bottom-up approach to tackle these barriers, also analyzing the institutional aspects of this issue. To conclude, the research pillar will also tackle the so-called energy-water nexus, an issue that is already a major geostrategic challenge for the Mediterranean region and that will likely become increasingly relevant in the future.

Financing of Mediterranean energy projects

With regard to the need for new financing sources and instruments for the development of energy projects in the region, new approaches need to be explored. Europe does have a role to play on this, particularly through its public finance institutions. Long-term public investors such as the European Investment Bank, the European Bank for Reconstruction and Development, Germany's Kreditanstalt für Wiederaufbau, Italy's Cassa Depositi e Prestiti and France's Caisse des Dépôts et Consignations, are already financing renewable energy projects in the region. However, the actions of institutions are not coordinated, and they avoid taking risks and fail to use their leverage to make the energy sector overall more attractive to investors. So the impact of their investments is essentially limited to financing pilot projects. The research pillar will investigate how the EU could coordinate the North African activities of these long-term public investors, to enable economies of scale and stronger leverage.

Furthermore, the research pillar will investigate how a stronger cooperation between the EU, SEMCs and the Gulf Cooperation Council (GCC) might be established. A strong complementarity exists between these regions. For instance, the wide availability of capital in the GCC, the great energy efficiency and renewable energy potential of SEMCs and the institutional support of the EU could represent the three main pillars of a new "triangle of growth". Private and public investors (such as Sovereign Wealth Funds) from the GCC are increasingly focusing their investments on the sustainable energy sector, with the aim of transforming oil wealth into energy efficiency and renewable energy technology leadership. Part of the investment could be directed to SEMCs, which has among the highest solar energy potentials in the world and which is already promoting several large-scale renewable energy projects. The EU should facilitate the implementation of this process by providing institutional support (both in terms of regulation and public finance) and technological know-how. In addition to this innovative financing scheme, others might include the settlement of new Euro-Mediterranean mechanisms designed to attract North American pension funds and Asian Sovereign Wealth Funds into the regional sustainable energy sector. Parallel to these macro-schemes, national mechanisms should also be explored with the aim of providing an additional, sustainable source of financing for the national sustainable energy plans.

The aim of this analysis is to propose a concrete and realistic roadmap for an increased EU-Mediterranean energy cooperation based on win-win strategies.

For a Sustainable Energy Transition in Sub-Saharan Africa

Sub-Saharan Africa is on the move. Since 2000, the region has seen rapid economic growth, expanding population, improving social conditions and progressive political liberalization. On the basis of these trends, sub-Saharan Africa energy use has risen by 45% since 2000.

In this framework, making energy reliable and widely affordable for the population has been and continues to be a key challenge in the sub-continent. In fact, sub-Saharan Africa is rich in energy resources, but very poor in energy supply. Just to give an idea, in sub-Saharan Africa only 290 million out of 915 million people today have access to electricity, and the total number without access is rising. According to the International Energy Agency (IEA), more than half a billion people, mainly in rural areas, will still be without electricity in 2040.

Efforts to promote electrification are gaining momentum all over the sub-continent but are outpaced by population growth. Although investment in new energy supply is on the rise, two out of every three dollars invested in the sub-Saharan energy sector since 2000 have been committed to developing resources for export. In this context, a severe shortage of essential electricity infrastructure is undermining efforts to achieve more rapid social and economic development.

According to the IEA, an investment of about $450 billion will be needed by 2040 to reduce power outages by half and achieve universal electricity access in urban areas. In order to meet the United Nations' Sustainable Development Goal of complete energy access by 2030, the scale of investment required needs to be consistently higher. This creates a huge financial challenge confrontable only by formulating new, innovative, energy financing schemes at both regional and global levels.

Notwithstanding the importance and size of these challenges, sub-Saharan Africa’s energy sector remains one of the most poorly understood parts of the global energy system, and very few international energy research centers have developed substantial activities on and in the region. In this framework, the aim this project is to contribute to understanding Sub-Saharan Africa's current and future energy challenges and opportunities. In particular, the project will:

- Highlight key actions in the energy sector that can contribute to a more rapid economic and social development in sub-Saharan Africa;
- Explore how modern energy, including electrification, could replace traditional energy sources in sub-Saharan Africa, also by analyzing previous successful international experiences;
- Examine the potential for arbitrage between renewables (including hydro) and fossil fuels, and between coal and natural gas, and the related impacts on regional power generation;
- Provide insights into the future role of renewables in the region's energy future, particularly in relation to the electrification of rural areas;
- Examine how existing and emerging oil and gas producers can maximize the value of their resources for economic development by taking into consideration previous international experiences;
- Identify the benefits that greater regional integration of the energy sector can bring, as well as mapping the future role of sub-Saharan Africa in the wider energy system, with particular reference to the Mediterranean region and Europe.

Topic	Main objectives
The future of European energy markets	- Explore the most sensible pathways of the European energy transition; - Explore original approaches to European energy infrastructure financing; - Analyze the architecture of European energy security, with a key focus on gas.
Towards a new Euro-Mediterranean energy roadmap	- Explore hydrocarbon cooperation in the region; - Analyze the pathways of regional sustainable energy transition; - Explore the potential for financing new energy infrastructure in the region.
For a sustainable energy transition in Sub-Saharan Africa	- Explore the link between energy, economic and social development; - Explore the issue of energy access; - Examine the potential for arbitrage between renewables and fossil fuels; - Explore the future role of renewables; - Examine how oil and gas producers can maximize the value of their resources; - Identify the benefits of greater regional integration of the energy sector.

Table 5: ESP's main research areas and their objectives

Training and knowledge dissemination

The overall aim of the ESP Program is to carry out scientifically sound prospective and policy-oriented applied research, targeted at political and industrial decision makers. This target can be achieved only on the basis of a strong academic standing. For this reason, the core activity of the ESP Program will be to develop rigorous qualitative and quantitative analyses, on which strong policy recommendations could successively be formulated.

This academic research will be disseminated in various ways, to reach out properly to the various levels of the international academic community:

- Academic studies will be published in FEEM's paper series 'Working Papers - Note di Lavoro'. The consolidated dissemination channels of this series will guarantee a broad international academic readership;
- Selected analyses will be submitted to international peer-reviewed journals such as 'Energy Policy' and 'Energy Economics';
- More extensive studies will be published as academic books by international publishing houses. Over the last year the ESP Program has collaborated twice with Palgrave Macmillan and, on the basis of this successful experience, the collaboration will be continued in the future. However, this does not rule out the eventuality of engaging additional international publishing houses;
- The ESP team will continue to deliver high level training/education in several international universities such as the Johns Hopkins University School of Advanced International Studies, the Sciences Po Paris School of International Affairs, the Sabanci University, the Università Cattolica del Sacro Cuore and several other prestigious universities and diplomatic academies worldwide. The ESP program also employs PhD students in its research program, therefore providing further on the job training. Concerning the Sub-Saharan African Energy research line, an agreement with Sciences Po Paris has been implemented, allowing the ESP program to take advantage of a number of highly selected

international students to contribute to its research, and at the same time for ESP to provide training to talented young researchers;

- Training activities at local academic institutions and think tanks will be developed in Africa, also in the framework of the "Pathways to Sustainability in Africa" cross-cutting theme;
- In addition to all these activities, a certain number of policy dissemination activities will also be carried out: see "third mission" hereunder.

Third Mission: policy relevance and support

Policy represents the epicenter of the ESP Program. Consequently, policy relevance stands as a critical feature of the Program. First of all, it should be emphasized that the activity of the ESP Program targets policy makers at various levels: European public institutions, national public institutions, energy industry, international development organizations, national development agencies, regional and local stakeholders. This wide range of policy makers will be engaged in various ways:

- Publications: first of all, policy-oriented analyses will be published in FEEM's series 'Policy Briefs - Note di Policy'. Secondly, selected analyses will be published in international policy-oriented journals such as the European Energy Journal and the Oxford Energy Forum. Finally, broader policy-oriented analyses will be published as books in the dedicated 'ESP Series' created by the Dutch publishing house Claeys&Casteels in 2016;
- Events: the ESP Program will continue its tradition of organizing high-level brainstorming workshops to facilitate discussions among policy makers of a variety of selected topics. In particular, the successful annual closed-door brainstorming workshop 'FEEM Gas Talks' will continue to be organized. In 2016 the first edition of 'Euro-Mediterranean Energy Talks' has been organized in cooperation with the European think-tank Bruegel. In future, 'Sub-Saharan Africa Energy Talks' might also be launched. In addition to this, high-level public conferences and seminars will also be organized, possibly in collaboration with other international think tanks, in order to enhance target potential;
- Media: a more general way to impact public policy discussions is to be engaged with the media. ESP researchers will continue to be actively committed in this front as well, by continuing the established collaborations with prominent international newspapers and news agencies such as the Financial Times, Le Monde, Reuters, Il Sole 24 Ore, Bloomberg, Forbes, Repubblica, Politico Europe and Hurriyet Daily News.

Third Mission: social impact and business development

Energy is, by definition, an issue of high social impact. Our research program will seek to make an adequate use of this aspect. In general, this can be achieved with the engagement of local, regional and international stakeholders. This is particularly important in the case of the project on Sub-Saharan Africa, to enable the sharing of best practices and to ensure capacity-building effects.

A research institution such as FEEM could, through its ESP Program, provide meaningful support to the development of entrepreneurship by providing small and medium size enterprises willing to engage in the energy and climate sector with a blueprint, based on previous international experiences, for moving within the sector.

This is particularly the case for Sub-Saharan Africa, as many international companies are seeking to enter the continent and exploit its vast energy opportunities. Analyzing how other markets have evolved at their early stage in similar economic contexts (e.g. South Africa) might disclose useful recommendations for avoiding the mistakes of the past. Entrepreneurs might find it useful to learn from these experiences, to enhance their activities and consolidate their business models.

In order to achieve this target, the ESP Program will explore the benefits of establishing partnerships with regional think tanks and research institutions having a solid outreach network in the respective areas of activity.

Collaboration with cross-cutting themes

The ESP program will closely collaborate with all cross-cutting themes. Because of the dedicated research line on Africa, the ESP program will naturally collaborate closely with this cross-cutting theme. This specific geographical focus, together with the one on the Mediterranean region, will be developed by the ESP program to address the role of energy for the socio-economic development of these countries, including their local development. This will also provide an opportunity to explore the issues of energy access, key to avoid accelerating the trend of migration. In the geographical areas at the core of the ESP program (Europe, the Mediterranean and Africa) the current Age of instability is also impacting the energy dynamics. A clear example of this is the spread of terrorism in the MENA region and its possible impact on energy infrastructure. To conclude, it should be stressed that all the analyses conducted by the ESP program will also be addressed in the perspective of the Agenda 2030.

Resource requirements

The ESP program is in its infancy. The next three-year period will be a crucial phase for its development, as the program will need to grow from a very small nucleus of researchers to reach the minimum critical mass required to become an established and internationally competitive and recognized research program. Replicating the success-story of FEEM's traditional research programs in obtaining international funding (i.e. Horizon2020 projects) will be the most sensible pathway for such a process. However, in consideration of the fact that Horizon2020 calls will be inconsistent with ESP's research themes at least until the end of 2017, the initial phase of the program will have to be mainly supported by internal FEEM funding. This is the only way to allow the ESP program to acquire a leading role on subjects of key importance not only for FEEM, but also for Eni and Italy. The future of European energy markets, the Mediterranean energy relations and the sustainable energy transition in Sub-Saharan Africa are all subjects destined to grow in importance over the next years. It is thus likely that substantial funding opportunities will arise in the future. An initial investment of FEEM in the development of ESP would allow the program to grow and become internationally competitive from the moment that substantial funding opportunities arise. Such initial efforts by FEEM should thus be considered as an investment that will surely provide its dividends in the near future. The ESP program will, of course, explore all the possible external funding opportunities that might ease this transitory phase and therefore support FEEM in its initial investment.

Overview chart

Topics	Research			Training and dissemination			Policy support			Social impact and business		
	2016	2017	2018 2019	2016	2017	2018 2019	2016	2017	2018 2019	2016	2017	2018 2019
European energy												
Euro- Mediterranean energy												
Sub-Saharan Africa energy												

Table 6: ESP's summary of the priority areas over time (Orange=High; Blue= Medium)

1.4. Society and Sustainability (SAS)

Introduction

The year 2015 marked an important step in shifting the current developing paradigm toward sustainability. The United Nations agreed to adopt the "Agenda 2030 for Sustainable Development" and the related Sustainable Development Goals (SDG's), a clear signal of the desire to enter a pathway for reducing poverty and preventing environmental degradation. Also, 195 countries in Paris agreed to adopt a climate deal to enhance mitigation and adaptation strategies (COP21). Societal changes are the heart of this paradigm shift, since societies, intended as complex systems where people, firms, markets and local authorities interact and influence each other, are asked to co-develop improvements in their abilities to prevent environmental damage and to deal with the consequences of environmental change. Against this framework, the necessity to put the society *as a whole* at the center of the research agenda and of the policy discourse as well provides the rationale for a re-organization of this research program.

Reorganizing the contents and the scope of the research program is instrumental in avoiding an excessive fragmentation in the area, which could threaten FEEM's well-established reputation on specific topics, such those described in the MITP, EIA or ESP programs.

The reorganization of SAS area is also functional for:

- embracing a rigorous scientific approach without diminishing its capability to translate theoretical research into practical applications for companies and policy-making;
- adopting a strong interdisciplinary approach, which could lead to a better collaboration with the other research programs and cross-cutting themes and exploring in greater depth the comparative advantages of the FEEM network.

With these objectives in mind, SAS will work to foster a general awareness and understanding of some of the rapidly emerging themes related to the issues of sustainable development in both the private and public sectors. The definition of the research area covered by SAS builds on two equally important research pillars, which differ substantially from each other as to the potential beneficiaries of the research outcomes, the investigation methods applied, and the topics covered.

Research

Firms, markets and sustainability

The evolution of human behaviors is narratively described as unsustainable in both its environmental and social dimensions. But awareness is now increasing in the world communities. Sustainability has finally become a determinant of human development as the evidence grows that an imbalanced pattern of environmental and social development can seriously endanger the resilience of societies. Climate change first requires actions, efforts and investments, both to ensure protection from and adaptation to the risks to be faced. The extent to which this acquired awareness would translate into market opportunities represents the core of the societal change for entry into the green growth pathway toward sustainability.

To encourage this transition, it is important that a) firms gain a better understanding of how climate change related risks impact current business models, in order to define, adopt and implement strategies to increase their resilience; b) markets provide a suitable environment for the innovative investments required by climate change and, in general, by social change towards more sustainable lifestyles.

The goal of this part of the research is to understand how firms respond to the environmental challenge and how markets evolve to meet the demand for sustainability in terms of new products and services. The research would also recognize the heterogeneity that distinguishes the developed from the developing countries, where the economies most likely are built on the presence of natural resources and hence are more exposed to the consequences of climate change.

Business and climate change risks

Climate change severely impacts the economic performance and the value of assets of companies operating in some specific sectors, such as energy, utilities or insurance. Extreme weather events pose questions about worker safety, infrastructure resilience and business continuity, and cause additional and sometimes unforeseen expenditures. At the same time, the GHG emissions and the carbon footprint related to the production of goods and services are progressively being perceived as critical factors for corporate reputation and market prospects as well, and must come to terms with the policy of investors increasingly attentive to the principles of SRI – Sustainable Responsible Investment.

The FEEM pilot project De Risk-CO – conducted in cooperation with a panel of selected Italian firms – has shown that, notwithstanding the relevance of many climate change impacts on business activity, this is an area totally lacking systematic investigation.

Therefore, the aim of the research is to: i) understand in depth if and how firms perceive, identify, assess/measure, manage, mitigate, monitor, and disclose climate change related risks; ii) identify their needs in terms of information and tools that would allow them to apply or improve climate risk management strategies; iii) provide direct support to bridge the identified gaps.

As reported below, the research must be accompanied by a scientifically founded public debate able to raise awareness on the importance of these risks that – despite differences in vulnerability (i.e. energy or insurance or agro-food sector) – concern strategic planning, investments, risk appetite, remuneration policy (LTI/MBO), asset evaluation (i.e. impairment tests), stakeholder dialogue, investor relations, and so on.

Business innovation for sustainability

The "Agenda 2030 for Sustainable Development" calls for all stakeholders to make a firm commitment to long-term plans of action, but a substantial part of the Sustainable Development Goals (SDG's) involves engaging companies in entering into decarbonisation trajectories, developing affordable and reliable clean technologies and experiencing new relationships with consumers and local communities. Accordingly, companies can significantly contribute to the societal change required by the objectives of the SDG's, while new development pathways put under stress the traditional business models.

For this reason, it is necessary to:

- conceptualize the specific drivers of the societal change connected to the sphere of businesses and analyze the potential for firms to respond to the SDG's challenge with "low and zero carbon" products, processes, and services and the extent to which this innovation may lead to business development in new markets;
- strengthen and innovate the companies reporting to the general public of stakeholders by disclosing business and financial information sided by non-financial information, useful for portraying the long-term sustainability of the business model;
- enable business change by rearranging routines, i.e. studying how the management decisions related to the organization or the operations are transmitted and perceived by means of business ethnography;
- understand the evolution of the financial sector, which can significantly influence a company's behavior through its investment choices; in fact, a growing number of institutional investors are adopting tools to assess the environmental impact of industrial activities and some have already decided to de-carbonize their investment portfolios.

Sustainable and resilient cities

Urbanization is recognized as a fundamental driver of environmental change, since it alters the functions of soil, reducing the availability and quality of natural resources, and fragmenting ecological corridors. Climate change is becoming a very urgent issue in global agendas, and with three-quarters of the world's

population living in urbanized areas, cities have become hotspots in which both problems and potential solutions to the environmental challenge are concentrated and hence called on to play a crucial role in promoting the economic and societal responses necessary for both mitigation, intended as the transition toward a low-carbon paradigm, and adaptation, as the capacity to anticipate, cope with, and protect from the adverse effects of climate change.

The objective of the research conducted within this pillar is to foster an understanding of the determinants of urban spatial development and the consequences for the environment, and to highlight the importance of a correct assessment of the economic value of ecosystem services through empirical and quantitative analyses ultimately aimed at producing evidence-based policy guidelines for sustainable and resilient cities. Attention is paid to both developed and developing countries, acknowledging the huge heterogeneity in demographic patterns across the world and with a special interest in Africa and Asia, where, according to projections, the growth of urban populations will be concentrated.

Land transformation has direct negative consequences on the C-cycle and the water cycle, and can seriously hamper the ecological equilibriums of large areas, increasing their vulnerability to extreme events. Calculating the sustainability of changes in land use can contribute to designing and implementing better planning policies for a transition towards resilient, low-carbon and resource-efficient cities. However, beyond planning, it is increasingly important to recognize the value of preserving the environment. The pressure on natural resources, directly related land uptake, is the main cause of the decay of ecosystems, and as such jeopardizes the sustainability of economic development. The need for a deeper understanding of the relationship between urban development, transport network, climate change and the protection of ecosystems is still high, and the field of investigation prominent.

Urban dimension of sustainability

Population growth is the primary driver of urbanization, and a substantial part of this growth is expected to take place in cities. Historical experience indicates that cities evolved following a monocentric organization of space, determined by the decay of population, rents, floor/area ratio, and an urbanized area at increasing distances from the city center. Nowadays, decentralization has become a frequent trait of most large cities, but the evolution of the monocentric structure has materialized through diverse pathways stemming from a more structured urban polycentrism to a chaotic scatteration of residential areas, with a multiplicity of intermediate solutions. What are the consequences of this evolution in relation to mitigation and adaptation capacity? What are the future trends and how will they affect the environment? And what policies can prevent excessive damage? These are the key questions summarizing the core of this research.

The first objective is to address the relationship between urbanization (in terms of demography, urban patterns, transport and mobility) and the consequences for mitigation and adaptation. The most significant environmental impact relates to GHG emissions, on account of both the loss of the soil function as a carbon sink and the change in frequency and modes of transportation. Indirect impacts also affect adaptive capacity, increasing the vulnerability of cities to natural events. Among these, it is worth recalling the risk of disasters associated with flooding, clearly concaused by soil sealing. For this reason, the scope of this research (jointly conducted with EIA) also extends beyond a simple understanding of impacts to the development of ecosystems and nature-based solutions (NBS) for reducing disaster risk and decarbonizing cities.

The second is to build a probabilistic econometric model that explains the dynamics of land use change at a high-resolution spatial scale that accounts for spatial interactions. Although models of land use change exist in literature, addressing spatial spillover effects explicitly is emerging as a significant innovation in the modelling approach. In fact, spillovers are important for enabling us to understand how the choice to transform land in a particular location spreads its effects to nearby locations, influencing land use there. The model serves not only as a tool for a better understanding of the complex relationship between land use and socioeconomic dynamics, supply of green and blue infrastructures and ecosystem services, but also for providing short-term forecasts of land use change and related consequences in terms of CO_2 emissions and air pollutants. The use of fine spatial scale data, GIS technologies / Earth observations and geographical

analysis, and econometric modelling to forecast environmental impacts are all elements commonly employed by the EIA division, with which SAS wishes to foster cooperation.

Economic evaluation of ecosystem services

Estimating the economic costs related to the depletion of ecosystem services is a frontier theme in ecological economics. The loss of natural resources, and in particular land, leads to significant costs that markets fail to consider and that determine important externalities. Market failures are often among the determinants of inefficient resource management. Valuing systems services is hence becoming of fundamental importance for ensuring correct market functioning and preventing unnecessary environmental deterioration caused by human activity. The goal of this research is to provide economically efficient tools for integrating the valuation of ecosystem services into resource management policies and planning policies at different levels. The research complements the efforts conducted by EIA to study the effectiveness of ecosystem-based solutions for disaster risk reduction, emphasizing the economic efficiency of these solutions. This part of the research is closely related to the project of mapping the EU's ecosystem services, which is currently taking place at EUJRC-ISPRA.

Topic	Main objectives
Firms and climate change risks mitigation	Understanding how Italian firms deal with climate change risks and the extent to which they manage to mitigate them. Building a culture of climate change as a key driver of a firm's evolution, by providing direct support to companies.
Business innovation for sustainability	Exploring the capability of firms to achieve SDGs through innovation in products, services, and processes connected to societal change. Understanding the role of the financial sector in improving the green evolution of business models.
Modeling land use change	Building an econometric model - at a high-resolution spatial scale – to produce reliable projections of land use change determined by socioeconomic and environmental factors (new infrastructures, population growth, GDP change, supply of ecosystem services, etc.) with spillover effects taken into account.
Urban patterns and sustainability (jointly with EIA)	Identifying the relationship between urban morphology and environmental quality, in order to understand how to reduce urban GHG emissions and the vulnerability of cities to natural events through sustainable urban planning.
Valuing the ecosystem services	Producing economic analyses by means of econometric models capable of evaluating ecosystem services and the costs due to their disruption or deterioration. Promoting the preservation of ecosystems by raising awareness of their value.

Table 7: SAS's main research areas and their objectives

Training and knowledge dissemination

Conferences, workshops and seminars will be organized to disseminate the achievements of the SAS program. Publications in international journals and in FEEM's Note di Lavoro remain the main target for scientific dissemination.

However, given the current reorganization of research activities, it is necessary to consolidate the research team and its members' capacity to build networks both with other FEEM areas and with external partners

before engaging in several training and dissemination activities. Nevertheless, over the next three years SAS will use of existing resources and connections at least to organize:

- In 2018, a workshop on the topic of mitigation and adaptation strategies for cities, possibly in cooperation with other research centers and universities. Both researchers and policy makers will be invited to the workshop;
- In 2019, a summer school on quantitative approaches for mapping and valuing the ecosystem services in Europe.

SAS will also organize a workshop to discuss and disseminate the outcomes of research on climate change risks for companies in the first semester of 2017.

The SAS program will participate in FEEM's training activities in collaboration with other programs. In particular, SAS will collaborate with EIA on the organization of a training program dedicated to capacity building of policy makers in Africa, with a specific focus on land planning and resource management.

Third mission: policy relevance and support of policy

All the topics framed in this research area are intrinsically connected to key policy questions that have recently emerged and are taking place at different levels, among which EU remains the most important normative source and policy arena.

Business and climate change risk

Climate change risk assessment, prevention, management, mitigation and reporting is an emerging theme following the entry into force of Directive 2013/34/EU on non-financial disclosure that requires specific accounting, also in light of the growing interest of financial analysts in ESG themes.

Despite increasing pressures, up to now very few firms seem equipped with a proper climate change risk management structure and strategy. Often, one of the major barriers to this is simply the fact that a firm's risk management is ignorant of the availability of adequate climate information and impact assessment tools or of the ease with which they can be produced by the scientific community. By conducting research in teams where companies are directly involved, SAS aims at addressing this divide, helping businesses to identify actions for assessing climate risks and planning responses and investments adequately. Placing itself as direct collaborator and interlocutor with businesses and stakeholders and, at the same time, as provider of climate change impact and risk analyses, SAS will be a reference subject in the community of firms and institutions oriented to promoting a "climate change risk resilience culture".

Business innovation for sustainability

The research conducted by the SAS program is concerned with the policy objective of introducing a culture of green innovation in the business sector. The economic potential offered by this paradigm still needs largely to be evaluated not only by the companies, but also by the institutions that should provide companies with a favorable environment for innovation and transition towards more sustainable lifestyles. Building on the results of its research, SAS can make a practical contribution by:

- identifying the industrial sectors where product, process, and service innovations are required by the societal change and the characteristics of the institutional environment that best support this innovation;
- analyzing emerging business models driven by an increasing awareness of sustainability;
- providing guidance and policy support to firms interested in better disclosing and presenting their capability to meet societal change and pursue long-term sustainability (so-called non-financial disclosure).

Urban dimension of sustainability

While the consequences for climate change of current and foreseeable urbanization are widely recognized, research on the quantitative assessments of its effects on climate change still lacks a systematic approach. Despite this, in the next few years, local administrations in the developed and developing countries will have an increased need for practical support to adequately plan mitigation and adaptation strategies. The research conducted in SAS, in filling this research gap, also aims at contributing to formulate practical solutions in terms of climate-oriented land planning and resource management in contexts of urban growth. This constitutes a significant knowledge content made available to local authorities, who are requested to implement their Adaptation Plans. In contrast to the National Adaptation Plan, which is inspired by a general policy of top-down actions, local plans are thought of as bottom-up, place-based and place-specific instruments. Designing these plans implicitly requires specific knowledge of local environment, such as local vulnerabilities and site-specific risks posed by climate change. But it also requires technical knowledge and skills to estimate the costs and benefits of strategies and to evaluate their effectiveness. Because this knowledge is not always in the hands of administrators, SAS can significantly contribute by helping administrations in the process of capacity building: i.e., the development of capabilities useful for designing and implementing effective mitigation strategies, maintaining and possibly reducing significantly emission levels and adaptation strategies, reducing adverse consequences of climate change by promoting the evaluation of ecosystem services, and ensuring the adequacy of planning and resource management policies in accord with the green growth paradigm.

Economic evaluation of ecosystem services

Until a few years ago, the preservation of ecosystem services was a central issue on the resources (Water, Forestry) policy agenda. With the EU's adoption of the Biodiversity Strategy to 2020, following the Conference of Parties (COP10), on which occasion the plan for Biodiversity was adopted, the theme of Ecosystem Services began to contaminate the full area of EU policies. Monitoring, defending and investing in ecosystem services is now presented as a strategic component of the plans devoted to promoting socioeconomic development in Europe, and both the Rural Development Policy and the Cohesion Policy are already dedicated in part to this topic.

The primary interest from the UE policy perspective is to map the ecosystem services, their geographical distribution and spatial concentration, and their plausible development. Nonetheless, there is increasing interest in evaluating how the ecosystem services affect human activities, who the beneficiaries are and how their values are managed. In this respect, the research conducted at SAS is highly relevant because it provides reliable quantitative tools for estimating the economic value that these services provide and the cost that a disruption of these services may create to communities. As such, the research flanks the efforts currently taking place at JRC-ISPRA to map ecosystems at the EU level and provide a valuable complement to the knowledge base necessary for implementing a Biodiversity Strategy. To maximize the policy importance of the research outcomes, some parts of the design and implementation of the empirical research will be jointly conducted with the JRC-ISPRA, thus contributing to expanding FEEM's network.

The outputs and methods of the research are also of interest for the institutions and policy makers at the regional level, since regions are requested to strategically plan investment actions to the benefit of ecosystem services and regional biodiversity within their rural development programs. Awareness of the economic value of these systems means that the institutions can better predict the economic returns from these investments and also attract private investments through projects that, leveraging on public financing, can turn into business initiatives that create value and jobs.

Third mission: social impact and business development

The SAS strategy for accomplishing the business development mission builds on the capacity of the Firms, Markets and Sustainability team to create networks with leader firms in the public and private sectors, especially in Italy, within which researchers operate not only by analyzing and representing the risks and the opportunities related to sustainability (societal change, climate change, green innovation) but also by

designing and implementing effective solutions. The efforts made in this area are targeted toward establishing FEEM's solid reputation as a strategic adviser for companies on the forefront of sustainability.

The research on Sustainable and Resilient Cities shows a lower potential for direct interactions with the business world but has very significant social impacts. These mainly arise in connection with local communities when translating the research results into the planning of adequate urban policies for reducing GHG emissions; the design of development strategies for preserving natural resources and the ecosystem services; the search for solutions to prevent and reduce the impact of climate change.

Resource requirements

As stated before, a critical refocus will involve the research fields of the SAS program. This reorganization requires diversifying the skills of the current team and, above all, advancing its methodological competencies to successfully match the goals assigned to the SAS program. As the reshaped program is at its very beginning, it appears evident that the next three years will be a critical stage in its full maturation.

SAS plans to establish a rigorous framework for the analysis and dissemination of sustainable business models, in order to meet the needs of the business sector to enable it to remain at the forefront of research and innovation. SAS also plans to develop scientifically grounded tools to model new research fields, such as those related to sustainable and resilient cities (i.e. urbanization patterns or ecosystem services).

These plans require internally funded investments in human resources in a medium-term perspective to enlarge, improve, and diversify – step by step – the current small team of researchers with the objective of their becoming able to raise funds from third parties, replicating the success of other FEEM programs. In the meantime, SAS will explore the potential of new sources of funding, such as NGO's or local/national governments, both in developed and developing countries.

Collaboration with cross-cutting themes

Both the research topics and the policy issues that define the scope of SAS touch upon FEEM's cross-cutting themes. The variety of investigation methods employed, stemming from case-study analysis to statistics, from econometrics to geographical analysis, also makes interactions with other disciplinary areas and teams particularly manageable.

Most future world population growth will be concentrated in African countries. All the questions arising about this demographic change and its environmental impact are highly pertinent to SAS research. In particular, research on the resilience of cities can help in understanding the climate implications of the demographic changes and in planning in advance adequate country-specific mitigation policies. Research on the economic evaluation of the ecosystems meets one of the central needs of these countries, whose economies substantially depend on natural resources, to build proper resource management policies and at the same time to adequately assess the vulnerability of the socio-economic system caused by damage to natural resources.

The vision of a sustainable development path directly involves firms and cities, respectively the two pillars of SAS research. By analyzing the factors that can assist or threaten the sustainability of firms and cities, the research also aims at clarifying how these subjects can contribute to reaching the SDG's and, overall, to the success of the Agenda 2030. The research builds on micro-level analyses and case studies with respect to firms and on territorial data analysis with respect to cities. Concerning the latter, it complements the indicator-based analysis of EIA by focusing on city-specific indicators of sustainability and representing sustainability at a finer spatial scale.

SAS connects to this cross-cutting theme by providing quantitative tools to estimate some of the environmental impacts related to migrations (urban growth and depletion of ecosystem services). In particular, the division can contribute with research on the effect of rural-urban migration in developing countries (in connection with the Africa cross-cutting theme) and on the sustainability of migration flows in developed countries (in connection with the Migrations cross-cutting theme).

Finally, SAS research meets FEEM's general ambition to boost knowledge through local projects by providing specific knowledge on the topics of green innovation and firm sustainability. This knowledge is highly relevant especially in projects requiring training and human resource managements because these represent important channels through which to promote the culture of societal change for green innovation that SAS studies. Another significant contribution comes from the analysis of the sustainability of cities that perfectly connects with the need of municipalities to build Local Adaptation Plans. The knowledge base and experience of SAS, combined with easier access to qualitative and quantitative information that the partnership with cities can provide, is an occasion to boost research on the policy effectiveness of local mitigation and adaptation strategies.

Overview chart

Topics	Research			Training and dissemination			Policy support			Social impact and business		
	2016	2017	2018 2019	2016	2017	2018 2019	2016	2017	2018 2019	2016	2017	2018 2019
Firms and climate change risks mitigation												
Business innovation for sustainability												
Modeling land use change												
Urban patterns and sustainability												
Valuing the ecosystem services												

Table 8: SAS's summary of the priority areas over time (Orange=High; Blue=Medium)

2. CROSS-CUTTING THEMES

2.1 Agenda 2030

Introduction

In September 2015 in New York, the General Secretary of the United Nations Ban Ki-moon launched the Agenda 2030 for Sustainable Development, composed by 17 Sustainable Development Goals (SDGs), with the aim of tackling the global economic, social and environmental challenges. This agenda is a road map for the planet that will build on the success of the Millennium Development Goals (MDGs) but MDGs likewise aspire to be universal and therefore address all countries and not only the developing ones. The agenda seeks not only to eradicate extreme poverty, but also to integrate and balance the three dimensions of sustainable development - economic, social and environmental - in a comprehensive and global vision.

If 2015 can be considered the "Year of Sustainable Development," 2016 is the kickoff year for the process of SDG implementation. On January 1, 2016, the world officially began implementing the 2030 Agenda by initiating the transformative plan of action based on 17 SDGs aimed at addressing urgent global challenges over the next 15 years. In this framework, on March 14, 2016 FEEM launched SDSN Italia, the national hub of the UN-SDSN network, led by Jeffrey Sachs, with the aim of translating the Agenda 2030 into local Italian settings by mobilizing Italian academic and research actors and connecting them to civil society and business leaders.

SDSN Italia builds on three main pillars: i) Contributing to the implementation of SDGs through scientific research and innovation; ii) Promoting knowledge and awareness of SDGs throughout Italian society by implementing dissemination, educational and training initiatives; iii) Identifying, proposing and realizing concrete solutions for sustainable development.

The recent "Sustainable Development Goals Report 2016" presents an overview of the 17 Goals using data currently available to highlight the most significant gaps and challenges. The latest data show that about one in eight people still lives in extreme poverty, nearly 800 million people suffer from hunger, the births of nearly a quarter of children under 5 have not been recorded, 1.1 billion people are living without electricity, and water scarcity affects more than 2 billion people.

Statistics show how important coordinated global data-generation efforts will be in supplying reliable and timely data for systematic follow-up and progress reviews. New technologies are leading to an exponential increase in the volume and types of data available, creating unprecedented possibilities for informing and transforming society and protecting the environment. Nevertheless, because of lack of resources, knowledge, capacity or opportunity, there are huge and growing inequalities in access to data and information and in the ability to use it.

Particularly relevant for the issue of the need for global data-generation is the publication compiled at the request of the United Nations Secretary-General by the Independent Expert Advisory Group on a Data Revolution for Sustainable Development in November 2014, "A World that Counts: Mobilizing the Data Revolution for Sustainable Development." The Report states that "data are the lifeblood of decision-making and the raw material for accountability." In this framework, the need to mobilize the data revolution for sustainable development in order to overcome the knowledge gap between developed and developing countries, between information-rich and information-poor people, and between the private and public sectors, is an urgent need for all people and the whole planet in order to monitor progress, hold governments accountable and foster the achievement of the Agenda 2030.

Research

The cross-cutting theme "Agenda 2030" will focus on the Sustainable Development Goals that are at the core of FEEM research, thus on SDG7 (Ensure access to affordable, reliable, sustainable and modern energy

for all), and SDG13 (Climate action). The cross-cutting theme "Agenda 2030" will analyze in particular the SDGs means of implementations, encompassing both financial and non-financial enabling factors aimed at facilitating the achievement of the Goals, e.g. Goal 7.a: calling for an enhancement of international cooperation to facilitate access to clean energy research and technologies, and promote investment in energy infrastructure and clean energy technologies; and Goal 13.a: calling for the commitment by developed country Parties to the UNFCCC to a goal of mobilizing jointly USD100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund. Therefore, it is evident how climate finance and clean energy infrastructure finance are crucial drivers to reach the level of investments required to achieve the Sustainable Development Goals, especially SDG 7 and 13.

As for the activities already conducted by FEEM on SDGs interaction is worth mentioning an analysis on the Sustainable Development Goals (SDGs) conducted with a primary focus on the SDG7 as the enabling factor for the achievement of the other SDGs and as a cross-cutting agent for the pursuit of the environmental, social and economic objectives underlined in the 2030 Agenda. The project involved researchers with different interdisciplinary backgrounds and from different FEEM research areas (former SIS and MITP) and aimed at analyzing the indicators that can be used by the different actors of society, including business, for measuring and monitoring the progress toward SDG 7.

Among FEEM traditional research activities and conditional to the in-kind research collaboration from all FEEM Research Programs, the following research topics on "Agenda 2030" will become the basis for the analyses:

Climate and energy infrastructure finance

This stream of research is aimed at assessing the financial resources needed to achieve the Goals, with a special focus on SDG 7 and 13. Research will be carried out to assess the size and dynamics of climate finance (from carbon pricing to green bonds).

Research already conducted at FEEM on the understanding of the evolution of the financial sector, and how it can significantly influence the companies' behavior through their investment choices will be further implemented. The Agreement reached at COP21 is driving a new momentum in climate policy worldwide, so that carbon intensive projects and investments will likely face an increasing risk of stranding. The concept of 'carbon risk' will be explored focusing both on the risks that carbon-intensive companies are exposed to ("operator carbon risk") and on the risks that is passed on to lenders and investors with a stake in these companies ("carbon asset risk"). (Collaboration with the SAS Program is envisaged).

A possible collaboration is envisaged with the SDG Center for Africa and its flagship Program on Financing for Sustainable Development. This Program will focus on further research, understand and enhance the role of national development finance institutions in the MENA region and in Sub-Saharan Africa for the SDGs (in connection with ESP research program and the Pathways to Africa Sustainability cross-cutting theme).

The Paris Agreement and the Sustainable Development Goals Agenda not only saw cities and regions taking the leadership in driving practical solutions, but also sent a powerful supporting long-term policy signal to business and investors. In this promising context, attention has shifted to accelerating the implementation of commitments made at COP21 and to the means of delivering the Sustainable Development Goal. These commitments will require investment of roughly US$ 93 trillion over the next 15 years, with over 70% of this in urban areas. Today's financing landscape however, does not provide cities with adequate access to finance this urban infrastructure change. To overcome these challenges, simultaneous and complimentary action is required, building capacity at sub-national and city levels, creating innovative and tailor-made financing tools, and strengthening markets to increase the quantity and flow of climate finance in low emissions climate resilient infrastructure (in cooperation with the EIA and the SAS Research Programs).

Modelling of SDGs

Aimed at evaluating three different research objectives: 1. The interdependencies between the most relevant SDGs and the policies; 2. The analytical assessment of the synergies and trade-offs involved in achieving the relevant SDGs in 2030; 3. The assessment of the feedbacks of the SDGs achievement on the economy. This strand of modelling research will be conducted in close coordination with the EIA and MITP Research Programs. We plan to continue and further develop the Assessment, Projections and Policy of Sustainable Development Goals (FEEM APPS) project in order to study the issue of economic, environmental and social impacts of public policies on sustainable development; to work on the feedbacks of the SDGs achievement on the economy; and to develop analyses based on the analytical assessment of the synergies and trade-offs involved in achieving the relevant SDGs in 2030. Most of the research on quantitative assessment of sustainable development indicators is carried out from an ex-post perspective, organizing and analyzing data collected by main statistical sources. APPS goes further providing also an ex-ante evaluation of future trends considering different socio-economic conditions under which SDGs will be met (or failed) by 2030. The APPS project can indeed be divided into two assessment phases:

a. Ex post Assessment: aimed at assessing the present state of sustainability by measuring SDGs through appropriate statistical indicators (Campagnolo et al., 2015; Farnia L., Giove S., 2015.)

b. Ex ante Assessment: assess the likely dynamics of sustainability by projecting SDGs into the future by means of macro-economic modelling frameworks (both through FEEM WITCH and ICES models).

Moreover, we will also further develop the Sustainable Development Goals – SDGs Interaction project (in coordination with all of FEEM Research Programs and CMCC). In particular, FEEM researchers will contribute to the SDSN project TWI2050, addressing the full spectrum of transformational challenges related to achieving the 17 SDGs with a longer term trajectory up to 2050, and reaping the benefits of potential synergies from achieving them in unison using an integrated and systemic approach.

Experimental research on energy access

Experimental studies are currently being conducted on issues related to access to energy (SDG 7.1) in developing countries, one focusing on the drivers of adoption of improved cook stoves in urban Mali, the second on the impact of solar PV on small business activities in rural off grid areas of Pakistan. For the future, we aim at enlarging the portfolio of experimental research projects in the area of SDG7 both in developing and developed countries.

Therefore, other than modelling another assessment approach which could be applied to Sustainable Development Goals is to be conducted in close coordination with the cross cutting theme “Pathways to Sustainability in Africa” and the MITP and ESP Research Programs):

c. Ex-ante and Ex-post assessment: evaluate the causal impact of programs and projects implemented by both private and public sector on outcomes related to sustainable development, using experimental and non-experimental design (see Bonan et al. 2015 for a literature review on SDG7).

The role of the private sector in achieving the SDGs

This research will focus on SDG 7 as the enabling factor for the achievement of all other SDGs, and in particular SDG 13, SDG 9 (Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation), and SDG 11 (sustainable cities and communities). The research already conducted will be further expanded by extending the role that the private sector could play in relation to the digitization of the electricity sector through smart meters for demand side management and smart grids for distributed renewable generation. This will be conducted thanks to the contribution of researchers from SAS and ESP research programs.

ESP researchers will contribute to the study of the growing path towards digital innovation in the energy sector and the role of energy companies towards the achievement of the targets set by SDG 7 (SDG 7.2, SDG 7.3), that are pivotal for the achievement of SDG 13 and SDG 9.

SAS researchers will contribute to the role that the private sector can give to the business change required by the SDGs objectives, and on the engagement of companies in developing affordable and reliable clean technologies and services, as well as experiencing new relationships with consumers and local communities. In particular, SAS researchers will contribute to the analysis of the role that the private sector can play for the achievement of SDG 7, SDG 13, and SDG 11.

In particular, following the recommendations of FEEM's Scientific Advisory Board, FEEM *will focus its research on a comprehensive vision of the global financing of SDGs and further stress the role of finance. There will be a permanent lack of the needed financing if we were to stay with the present distribution of responsibilities between the private and public sector. Research will focus on the policy tools and on incentives to Public Private Partnerships (PPPs). The energy infrastructures and interconnections financing is highlighted as a priority also in the governmental agenda.*

Training and knowledge dissemination

Knowledge dissemination will be pursued through all traditional FEEM channels and through publications in international journals. Workshops and other dissemination events on the Agenda 2030 will be organized.

A pilot program of seminars dedicated to Italian high school students presenting the major themes related to climate change science impacts and policies and/or sustainable development and promote pro-environment, sustainability behaviors will be launched by EIA in close coordination with the cross-cutting theme "Agenda 2030". This activity will be developed in cooperation with all the other FEEM research programs, in particular MITP.

As for educational projects addressed to primary and secondary schools as well as university students will be conducted by FEEM in collaboration with SDSN Youth - the global youth division of the Sustainable Development Solutions Network (SDSN) – AIESEC – the largest student association around the world -— and the University of Siena as hosting institution of SDSN Med, and potential other partners. The project will be realized by leveraging the academic and research community linked to the SDSN network, and especially building up from the just launched SDG Academy. The project aims at mobilizing a global movement of young people to foster the understanding and adoption of the Sustainable Development Goals (SDGs).

Another training activity to which this cross-cutting theme will contribute to is the research proposal of a Marie Sklodowska-Curie Fellow, Robert Mizo, from the University of New Delhi, who - if successful - will conduct research on "Implementing SDGs: A comparative study of public and private actors in China and India".

Third Mission: policy relevance and support

The activity of policy support conducted by the cross-cutting theme "Agenda 2030" will focus on three main initiatives:

- Strengthening of FEEM collaboration within the UN-SDSN and SDSN-Med in the framework of SDSN Italia, the national hub of UN-SDSN hosted by FEEM, along the relevant SDSN thematic areas.
- Fostering the collaboration with International Institutions such as UNEP-FI, SDG Center for Africa, Global Compact Network, WBCSD, GGKP, C40, Regions for Climate, Cities Climate Finance Leadership Alliance, etc.
- The dialogue with the most relevant institutions and organizations at the national level (MATTM, MAECI, ASviS, ISTAT, etc.), in view of the update of the "Strategia Nazionale di Sviluppo Sostenibile" due by the end of 2016, and at the international level (UN-SDSN, Inter-Agency and Expert Group on SDG Indicators - IAEG-SDGs, etc.).

- Issuing guidelines for policy makers that may resume the state of the art on Agenda 2030, analyzing the critical aspects and proposing possible solutions with an approach towards problem-solving such as the financial resources to achieve the Goals.

Third Mission: social impact and business development

The social impact and entrepreneurship development activities will be carried out (in close coordination with the SAS and MITP research programs) by:

- Adding value to the business contribution to sustainable development, especially in relation to the mitigation targets of 2°C and 1.5°C defined by the Paris Agreement and the National Determined Contributions (NDCs).
- Promoting innovative business models and their dissemination at the national and international level with the aim of increasing the visibility and reputation towards potential investors, donors and partners.
- Supporting firms in innovatively designing, implementing and evaluating initiatives (both in core business and CSR) aimed at contributing to the Agenda 2030.
- Promoting advocacy activities toward the Youth. An example is the FEEM Contest "Youth in Action for the SDGs" in collaboration with SDSN Youth, AIESEC Italia and Fondazione Italiana Accenture.

2.2 Climate Change and Migrations

Introduction

Human migration has been identified as an important response to climate change. By worsening the living conditions in certain places or even making habitation impossible, climate-related stress forces individuals to move from one place to another. Migration is an important factor of adaptation to climate change. A well-known historical fact such as the American Dust Bowl during the 1930s provides evidence of the importance of migration as a form of adjustment to environmental stress. Roughly 2.5 million people migrated across the US as a consequence of the prolonged severe drought and intensive land use that caused large dust storms.

While a vast literature has so far analyzed how warming or other climate related events affect income per person across countries over the long run, the analysis of the link between climate/weather change and migration has so far been under-researched and deserves investigation. For example, very few studies have looked at the systematic long-term effect of temperature change on emigration and rural-to-urban migration in poor and middle-income countries in the world.

Moreover, future projections of the expected migration flows at the global level have so far been produced on little scientific evidence. These studies have attracted media attention but they have not been developed with rigorous methods, and they are typically not peer reviewed and cannot be replicated. The recent Fifth Assessment Report of the International Panel on Climate Change has not endorsed these studies, nor does it provide any estimate of the future number of climate migrants.

With the climate change that current concentrations of greenhouse gas have already committed us to, environmental stress is bound to increase, and it has become extremely important to quantify the expected patterns of climate-induced migration.

The analysis of environmental induced migration is a new research frontier that can have impacts on all of FEEM's research programs. Strong collaboration can be envisaged between the cross-cutting theme and the other research programs.

First, the analysis of climate-induced migration can contribute to a better understanding of the dynamics of the demographics in the major world economies, which is a key component of the energy-economic modelling of MITP. MITP and the cross-cutting theme will therefore collaborate with the ultimate goal to include the representations of migration into the climate change modeling framework. FEEM-MITP can also offer guidelines on how to conduct projections, which is a crucial component of the planned research in the Climate Change and Migrations cross-cutting theme.

Second, the cross-cutting theme can collaborate with the EIA program, sharing the large body of knowledge related to climate adaptation in various contexts and contributing to produce geo-referenced vulnerability mapping and high resolution climate indicators.

Third, connections with the ESP program are envisaged as far as energy and energy access are concerned. Improvements in terms of a widespread energy-access are key to avoid accelerating trend of migration. Moreover socio-economic development, which will narrow the gap between developed and developing countries, can be achieved supporting a sustainable energy transition in the source country of migration.

Finally, the SAS and the Climate Change and Migrations cross-cutting theme are connected through a common interest in urbanization. An ultimate goal of the SAS program is to produce evidence-based policy guidelines for sustainable and resilient cities, and rural-urban migration is a key driver of urban growth. The cross-cutting theme and SAS will collaborate in better understanding the determinants of urban spatial development.

Following FEEM's Scientific Advisory Board recommendations, FEEM *will play a major role in the international research and policy debate by focusing on the issue of climate induced migrations: this topic is essential for any political vision of what the future could be. It deserves the highest priority*.

Research

This cross-cutting theme of research aims to fill in the existing gaps in the literature by analyzing the role of migration as an adaptation response to climate induced environmental stress, and by identifying the potential indirect effects of climate-induced migration. Research on this topic has already been undertaken by FEEM in 2016. Given the key importance of this topic, new research is planned and will take place in the coming years in order to push forward our understanding of the migration-environmental stress nexus.

Human migration and complex indicators of climatic stress

The actual link between climate-induced environmental stress and migration will be further scrutinized. Previous research by FEEM analyzed the effect of differential warming trends across countries on the probability of either migrating out of the country or from rural to urban areas. The study finds that higher temperatures in middle-income economies increased migration rates to urban areas and to other countries. On the contrary, in poor countries, higher temperatures reduced the probability of migration to cities and to other countries, consistently with the presence of severe liquidity constraints. In middle-income countries, migration represents an important margin of adjustment to global warming, potentially contributing to structural change and even increasing income per worker. Such a mechanism, however, does not seem to work in poor economies.

Future research will extend these analyses by including more complex indicators of climatic stress. So far migration estimates check for average temperature and precipitation, as well as a simple variable capturing extreme events, such as the incidence of droughts, floods, storms and extreme heat. More sophisticated indicators of climate factors that are suitable for evaluating not only the effect of changes in average conditions but also changes in the extremes. In addition**,** future work will also project forward the resulting patterns of migration, extending the analysis into the future, based on projected changes in temperature, precipitation and other indicators of climatic stress. With this exercise we intend to produce a global assessment of the vulnerability for both origin and destination countries, expressed in terms of predicted inflows and outflows. An important output of the project will be a graphic visualization of spatially-informed projections of bilateral migration.

Channels linking climate and migration

The existing literature that studies migration as a response to climate-induced environmental stress has said little about the channels and mechanisms through which the relationship between climate change and migration takes place. It is of paramount importance, however, to obtain a precise understanding of the channels and mechanisms through which changes in the environment could affect migration. For example, migration could be a reaction to the negative effect of environmental stress on crop productivity, which would ultimately influence migration. Another potential channel which so far has been under-researched is the risk channel. Given that a more unstable environment implies increased risks, a family may resort to migration with the ultimate goal of reducing uncertainty. It is therefore possible that households choose to diversify income sources, engaging some members in activities external to the family business.

Climate change, natural resources, migration and conflicts

Climate-induced migration may induce indirect effects on resources and populations, generating ripple mechanisms that affect regions located at a great distance from the ones directly hit. For example, migration might cause new sources of stress in the receiving countries and might become a driver of social unrest. Research undertaken so far by FEEM studies the effect of climate-induced migration on civil conflicts and civil wars world-wide. What emerges from the analysis is that gradual warming and precipitation change may not be an additional source of unrest in migration receiving areas. Conversely, lower available resources and the inability of migrate might exacerbate local conflicts in origin areas.

We plan to extend this analysis in different directions, disentangling different types of migration (e.g. migration waves induced by gradual climate change versus those induced by extreme climate shocks) and looking at different types of conflicts. It may be the case that fast-onset events, such as extreme heat, flood or other types of climate events, such as drought, rather than gradual changes in temperature and precipitation, increase the incidence of civil conflicts in receiving countries. It could also be the case that climate-induced migration promotes inter-country conflicts between the origin and the destination of the migration flows, rather than civil conflicts in destination countries.

Another possible line of research will analyze the role played by social and political distributional factors (e.g. distribution of ethnic groups, environmental resources), and income inequality on social instability and conflicts. Global warming, together with social insecurity ranks among the top risks for the economic system and the aforementioned mediating factors may play an important role in shaping the resilience of human systems to recover from climate related shocks. This research will first identify the key mediating factors among institutions, ethnic diversity, socio-economic, and environmental distribution that influence the ability of economic and social systems to respond to climate variability and climate change. Second it will assess how the identified mediating factors will affect countries' resilience to the risks posed by future climate change and climate variability.

Training and knowledge dissemination

Training

Internship and visiting positions are available within this area of research. Motivated students and scholars will be offered the opportunity to deepen their knowledge of the link between climate change and migration. Post-doctoral fellowships under the Marie Skłodowska-Curie Individual Fellowships will also be available. A collaboration has already been established with Marina Mastrorillo of Princeton University, who has submitted a proposal under the Marie Skłodowska-Curie Individual Fellowship on climate-induced migration: "Towards a quantitative assessment of the Environment-MIGRation nexus: Building a foundation for African maps of mobility –EMIGRA".

Knowledge Dissemination

Given the importance of this cross cutting theme, FEEM has already taken important steps to foster dissemination and networking activities. FEEM will organize a Conference on "Climate-Induced Migration". The conference aims to deepen our understanding of the impacts of climate-induced environmental stress on human systems, with a particular focus on migration. It aims to shed further light on the actual link between environment and migration, the channels by which environment and migration are related and the indirect effects of climate-induced migration. The conference intends to bring leading experts from various relevant disciplines and domains that carry out research related to migration and climate/disaster. During the conference, leading experts from the academy will describe their latest research and will participate in a policy roundtable with prominent members from organizations most involved in policy making. The aim of the policy roundtable is to discuss pressing issues and explore ways to contribute to migration policies that take into consideration the latest results on the connection between climate change and migration.

Third Mission: policy relevance and support

A better understanding of the links between a changing climate and migration, and the implied indirect effects, is a key factor in designing policies for achieving security and developing goals. Climate change is a truly compelling issue, which sees increasing flows of migrants streaming into Europe. This cross-cutting theme of research will provide guidance for designing policies aimed at facilitating adaptation and leading to manageable waves of migrants heading for Europe.

Moreover, the UN's Framework Convention on Climate Change recognizes migration as a legitimate and effective adaptation under its Cancun Accords. In various chapters of the IPCC's Fifth Assessment report human migration is considered as an important adaptation to climate change. Despite its importance, there is a dearth of research on this topic, given the complexity of its ramifications and underlying mechanisms. This cross-cutting theme of research will be instrumental in providing a research-oriented, analytical

assessment which would fill critical gaps in research and be important for EU policies with an external focus, including border security, conflict resolution and development.

To put these objectives into action, the Climate Change and Migrations cross-cutting theme will exploit external funding opportunities. In particular, FEEM has been invited to join a consortium to respond to a call in the Horizon 2020 research program (ENG-GLOBALLY-03-2017: "The European Union and the global challenge of migration"). The results of the envisaged research aim to enhance greater policy coherence and effectiveness in the field of migration management and relations with third countries. The research will identify and depict good practices and effective ways to manage incoming and transiting migration at the benefit of local communities and immigrants. It will allow a better understanding of the interplay between migration and development processes. Research will give EU and national policy-makers stronger conceptual tools to better interpret the role of the EU and its Member States as global actors in the field of migration.

Third Mission: social impact and business development

The expected research along this topic aims to provide "win-win" solutions for the mutual benefit of EU and non-EU countries. First, manageable waves of migrants directed to Europe can alleviate potential security threats for Europe. Second, it should be noted that human relocation is costly and disruptive and it is often considered a last resort adaptation measure. Farm households can instead adopt climate resistant crops, choose a mix of crop and animal farming, invest in irrigation, or purchase weather insurance against a major source of agriculture production risks. In this framework, a better understanding of the channels linking climate and migration can produce social impacts for migrants.

2.3 The Age of Instability

Instability and related uncertainty are a pervasive phenomenon affecting all areas of our societies, from financial markets to food production, from energy sources to the development of cities, from crime and war to health and virus control, from increasing unemployment to migration flows. Instability is above all a political phenomenon, related to inadequate world governance and to the difficulty of providing global public goods. Instability is related to economic and cultural divides, to excessive differences in income distribution, to political and economic wars over resource control. Political, economic and social instability is further enhanced by climate change, a phenomenon that can increasingly be perceived and that is heightening and broadening many of the existing challenges for our societies.

Objectives

The objective of this cross-cutting theme is therefore twofold. On the one hand, to link up FEEM's research on sustainability with more general economic, political and social issues. This will help identify synergies and multiplier effects between the environmental dimension of future development and the economic and social ones.

On the other hand, the objective is to create a community of thinkers, business and political leaders and young entrepreneurs who gather to discuss a long-term vision for our societies and identify challenges and opportunities provided by the uncertainties and instabilities characterizing our times.

Issues to be addressed

This cross-cutting theme will help all research programs to broaden their views and try to understand how their research can shed light on some of the major instabilities of our century. Some examples of first issues to be addressed through a series of seminars and conferences are:

- Political instability and the role of energy
- Increasing differences in income distribution
- The digital revolution and related potential job loss
- The fight over increasingly scarce natural resources
- The uncontrolled spread of new diseases
- Lack of food and water in poor world regions
- The increased frequency of extreme weather events

Dissemination

Regular meetings will be held to talk and inform about some major unstable transition processes, from the digital revolution and its impacts on jobs to the eradication of poverty and its impacts on political stability, from the future of fossil fuel resources to the difficulty of governing the economic and financial dynamics of our world.

Following FEEM's Scientific Advisory Board recommendations, in 2017 *FEEM will organize a high-level conference on the "age of instability" cross-cutting theme, to bring together the main experts from different disciplines to address the issue of instability from several points of view. Connecting different research areas could be the winning strategy.*

2.4 Pathways to Sustainability in Africa

Introduction

Africa represents a crucial challenge for Europe, not only because of its geographical proximity, but also for historical, geographical and political reasons. In particular, Africa shares some key problems with Europe: from the use of natural resources to the need for sustainable socio-economic growth, from the definition of new governance in its role along the north-south and east-west energy axis to the complex issue related to migratory flows. Despite Africa's strategic importance for Europe, the African continent in its complexity is among the least studied themes in Italian research centers, and very few Italian institutions conduct actual on-site research on Africa.
Recognizing the key importance of the African continent, FEEM aspires to become a catalyst for ideas and new studies on Africa and in Africa, as well as to start a pathway structured on three levels, separate but complementary:

- Scientific activities, studies and research - also in collaboration with the main national, institutional and scientific centers interested in the African continent, such as IAI, ASPEN, MAE, ISPI and others - to extend FEEM's own fields of research with geostrategic, cultural and social analyses, which are required in order to undertake a cultural elaboration that keeps in mind the complex and heterogeneous African reality.

- An articulated pathway for strengthening abilities, skills and potential of Academic system and research centers in some countries of the Sub-Saharan area by means of high-level education courses and scientific research, in cooperation with universities and local research centers, on the issues of sustainable development, decarbonization strategies and access to energy.

- Implementation and consolidation of a vast and articulate international network of scientific and decision-making institutions in Africa, made up of universities, companies, research institutes, *think tanks*, inter-African forums and scientific associations.

In particular, following the recommendations of FEEM's Scientific Advisory Board, *FEEM will develop:*

- research and knowledge dissemination initiatives both on Africa and with Africa;
- collaborations to help local institutions in Africa to produce research of real academic quality, also encouraging other institutions to do the same in order to get a more balanced flow of ideas from north to south and vice versa;
- links and enhanced cooperation between its own researchers and local researchers in order to enhance academic standings and achieve policy impacts;
- initiatives to take advantage of African (or in general foreign) researchers who are already in Milan to create a community working on sustainability and related issues in specific geographical areas.
- focused research on adaptation in Africa. FEEM SAB believes that little emphasis is given to this topic in most research addressing the climate change issue. The SAB recommends focusing on national policies to implement adaptation measures in developing nations;
- moreover, eventual field experiments in Africa could be developed as a unique opportunity for African partners to work with one of the major companies in this sector, producing new data and some kind of policy experiments.

Research

The aim of FEEM's "Pathways to Sustainability in Africa" cross-cutting theme is to consolidate FEEM's current research activities related to this continent and to increase FEEM's knowledge on Africa from an economic, social, energy and geostrategic point of view, so that it can become a reference point in Italy on these issues, for acquiring knowledge and skills and also transferring them in Africa to university professors,

opinion leaders, policy makers and future African managerial classes, by means of active scientific collaborations and high-level education courses. An extension of research topics and a cross-cutting cooperation are crucial for creating the cultural preconditions to deal with a complex continent like Africa, and also to transfer knowledge and skills through two different complementary approaches as follows.

Towards a Think Tank on Africa and for Africa

Institutional and scientific activities in Italy, with the aim of becoming a think tank of national reference on a variety of interconnected themes: (i) climate change and the sustainable development of the African continent, focusing on adaptation as a pre-requisite to economic growth; (ii) resource scarcity and resource allocation in Africa; (iii) African "nation-building" processes; (iv) the role of the African continent in future energy scenarios; (v) the identification of environmental policies, water policies in particular, to foster sustainable development.

Towards a Think Tank in Africa

Active cooperation by FEEM with the SDG Center for Africa, an initiative promoted by the UN's SDSN in July, 2016 in Kigali, Rwanda, in order to create a continental hub for the promotion and implementation of Agenda 2030 activities. FEEM will cooperate with the Center, providing its scientific support by collaborating in scientific research and conferring scholarships to local FEEM researchers for in-depth investigation on issues relevant to Eni in the Sub-Saharan area, such as: obstacles and possible solutions for access to energy, use of natural gas in the Sub-Saharan area, development of non-conventional energy infrastructures and an analysis of local energy markets, main climate change adaptation issues, at a national and interregional level, climate finance and urban resilience in climate change adaptation.

With these aims, the "Pathways to Sustainability in Africa" cross-cutting theme – on the basis of its recognized expertise – will aggregate and systematize the scientific research activities already developed by its researcher on the issues of decarbonization strategy and management of climate change impacts, and adaptation and mitigation in Africa, thus creating a bond of mutual influence with new scientific activities carried out in cooperation with Italian and European researchers and institutions (in the form of fellowships, call for papers, joint presentations in workshops and seminars, and FEEM's dedicated publications). In this activity, leading national and international scientists, scholars and experts will be invited to present their studies on the ongoing international geopolitical and social processes and to share their thoughts on future African governance scenarios. A first proposal of new topics includes a crossed in-depth analysis carried out through scientific cooperation with institutions and national and European research centers on the following topics:

Sub-Saharan Africa: limits to development

Research on nation-building in Sub-Saharan Africa to foster an understanding of the evolution of an area considered of key importance for both the current and future balance of world power, the control of energy resources and use of the revenues obtained from their extraction and sale. Research on Sub-Saharan Africa opens the debate on the African frontiers of radical Islamism.

A non-oil rent-seeking destiny

Research on the relationship between welfare systems, economic development and reduction of social tensions in countries with an oil-rent-seeking economic and political regime aimed at creating a non-rent-seeking economic and social development model. This will include the subsequent investigation of the possible transformations in natural, economic and socially enduring equilibriums.

Collaborations on both the dissemination and research activities on these topics will be established with major research institutes in Europe and Africa. The most important ones are "L'Institut des Etudes Africaines" of the University Mohammed V in Rabat, the "Parkour Etudes Africaines" of the University of Paris Pantheon- Sorbonne and the University of Geneva. Other important centers with which a collaboration will be proposed are the 'African Studies Center of the University of Leiden, the African

Studies Center of New York University, and the Center of African Studies of SOAS in London. A partnership with the "Mo Ibrahim Foundation" that delivers courses on "Building Skills, Developing Talent and Enabling Africans to improve the qualities of governance in their country" would also be important.

Among FEEM's traditional research activities, and in collaboration with all of FEEM's Research Programs, the following research topics may become the basis of an analysis activity in Italy and in Africa, and they could also be used to transfer knowledge and skills to university professors, opinion leaders and local ruling classes in the Sub-Saharan area.

Mitigation Strategies for Sub-Saharan African countries
In collaboration with the MITP research Program, the "Pathways to Sustainability in Africa" cross-cutting theme will delineate mitigation strategies for targeted Sub-Saharan African countries by using MITP integrated models that make it possible to identify the optimal energy mix for achieving NDCs objectives and appraising the investments proposed in terms of their social and economic impacts. Moreover, FEEM Africa will also collaborate with MITP on the topic of energy poverty, promoting field work to access incentive to foster energy efficiency and the adoption of clean technologies and to investigate the costs and benefits of different solutions and suggestions regarding policies and business decisions that enable effective interventions.

Climate change impact and adaptation: analyses of Sub-Saharan African countries
In collaboration with the EIA research Program, the "Pathways to Sustainability in Africa" cross-cutting theme will focus on individual Sub-Saharan African countries by analyzing climate change impact and adaptation, such as the direct and indirect economic costs of climate change, the impacts on the productive activity of different sectors and, more generally, the vulnerabilities and challenges to development and the potential solutions in collaboration with local stakeholders, policy makers and experts, in order to offer effective and practical solutions for implementation.

Sub-Saharan Africa: energy challenges and opportunities
In collaboration with the ESP research Program, the "Pathways to Sustainability in Africa" cross-cutting theme will analyze in depth the infrastructural and financial policies pertaining to the development of renewables and energy efficiency in targeted Sub-Saharan African countries, from an international perspective and a wider regional and interregional geo-energy perspective, highlighting key actions in the energy sector to foster social and economic development in Sub-Saharan countries, exploring challenges and solutions on the issue of access to energy, analyzing the potential of the development of energy mixes (renewable, fossil fuels, gas and coal), exploring the potential of renewables, particularly in relation to the electrification of rural areas, and foreseeing the future role of sub-Saharan Africa in the African and Mediterranean energy system.

Access to energy and impact assessment of economic development programs
In collaboration with the MITP Research Program, studies and research on impact assessment of economic development programs and subsequent policies related with access to energy, energy poverty, adoption of clean and efficient technologies in the energy field, adaptation strategies in agriculture, women empowerment.

Environmental Crisis, conflict and migration flows from Africa
Analysis of the climate change-conflicts-international migration nexus through the use of historical data and climate scenarios, with the aim of quantifying international migration produced by the environmental crisis now and related conflicts. The analysis will study bilateral migration and will focus on all African countries, intended as countries of origin of migration. In the analysis, sophisticated climate indicators will be used, with the aim of detecting not only the variations in temperature and precipitation that occurred over time, but also the intensification of extreme events, such as floods and drought.

Population growth and ecosystem services in Sub-Saharan Africa
In collaboration with the SAS and EIA programs, the "Pathways to Sustainability in Africa" cross-cutting theme will analyze the connection between population growth and ecosystem services in targeted Sub-Saharan countries, highlighting the nexus between demographic growth and environmental impacts, addressing the topic of the resilience of the cities for designing country-specific mitigation policies, analyzing the effect of migration in targeted countries (both rural-urban and interregional migrations), investigating the stock of each country's natural resources, and assessing the vulnerability of the socio-economic system caused by the depletion of ecosystem services.

Training, Knowledge Dissemination and Main Collaborations

This scientific research goes hand-in-hand with high-level training, education and dissemination activities, developed for both the Italian scientific community and for institutional (governments, NGOs and international agencies, policy and decision makers) recipients and realized through workshops, lectures, closed meetings, and the organization of international events in collaboration with the principal scientific inter-African and international networks.

In the African continent – and in particular in the Sub-Saharan area – "Pathways to Sustainability in Africa," with a specific focus on the general issue of "natural resources, access to energy and sustainable development in Africa," will provide for the growth and educational opportunities of research centers and local universities, as well as opportunities to join the international scientific community through research activities, links to the main international and inter-African scientific networks, international scientific dissemination activities, organization of conferences, lectures, workshops and high-level education events, facilitation in publishing research outputs via FEEM's communication channels and in the most important international peer-reviewed scientific journals, support to local researchers for applying to funding calls promoted by international organizations.

To this aim FEEM will create specifically designed programs to support researchers and local university professors on selected issues explored by its research activities, implementing regional workshops dedicated to the transfer of scientific skills (teaching workshops) and promoting closed meetings among participants in order to discuss the initiated activities and their partial and final results (research workshops).

As for dissemination, for the first year of activity (2017) two international conferences –to be held in Italy and one in Africa – are expected to display the kick off of the project. These conferences, organized in cooperation with international institutions, universities and research centers, will host lectures and scientific analyses focused on main issues related to sustainable development of Africa (such as finance and climate change, nexus water-energy-development, demographic trends, development and energy needs, adaptation and mitigation) and presented by international speakers. Moreover, in occasion of COP23 to be held in Asia in 2017, FEEM will support the organization of side events focused on adaptation and development in Sub-Saharan Africa.
In 2018, accordingly with the development of the "Pathways to Sustainability in Africa" cross-cutting theme, other international events will be organized in collaboration with Italian, international or African research institutions and universities, as - for instance - an international conference on the relationship between migration, climate change and access to energy in Sub-Saharan Africa and a workshop on "Financing resilient cities in Africa", to be implemented in an African capital and in collaboration with local research institutions.

Third Mission: Policy relevance and support

The "Pathways to Sustainability in Africa" cross-cutting theme will support the creation and development of a network to foster scientific dialogue between universities and research centers based both in Europe and in Africa to support the definition of sustainable development strategies consistent with the Agenda 2030,

the related SDGs and the Paris Agreement, utilizing a vast articulated network of international contacts, among which the IPCC focal point for African countries, the SDG Center for Africa, the Green Growth Knowledge Platform (GGKP), the International Growth Centre (IGC), and the International Research Network for Low Carbon Societies (LCS.RNet).

The "Pathways to Sustainability in Africa" cross-cutting theme will also cooperate in creating SDSN Centers in the specific Eni countries of interest (on the model of SDNS Italia), by networking with other worldwide SDSN hubs, involved universities and research centers. Simultaneously, FEEM can develop an activity of promotion and support of the local Global Compact networks in Africa, in line with Eni's commitments as a member of the UN Compact LEAD and with the aim of activating interventions and actions of the private sector for local sustainable development.

The creation and consolidation of a high-level network could be an important lever in terms of economic sustainability, allowing FEEM to leverage on high-level partnerships such as The Earth institute, IMF, IEA, IRENA, KAPSARC, IPCC, UN SDSN, UNDP, The Association of African Universities, and the Green Growth Knowledge Platform; this will make it possible to apply for funding from third parties as well as to international calls with project proposals developed in partnership with parties belonging to the network (the African Development Bank, the World Bank, Cities Alliances, IGC, EEP, USAID, DFID, 3ie, Global Alliance for Clean Cookstoves, and the Swedish Development Authority).

Third Mission: Social Impact and Business development

In the long run, FEEM's activities in Africa will aim at promoting processes of inclusive and sustainable development, acknowledging the crucial importance of local cultures, in accordance with the goals of Agenda 2030 and of its SDGs and with the conclusions of the COP21 conference in Paris, including all the relevant stakeholders, in total agreement with Eni, in a way that generates a real impact in the medium and long term, and capable of promoting positive effects in its territorial context from a social, economic and entrepreneurial point of view. Thus, the activities of "Pathways to Sustainability in Africa" will be able to support, directly and indirectly, the territorial context and promote local development actions in accordance with the indications of the Agenda 2030, in particular concerning the issues of access to energy, quality education, women's empowerment and gender equality.

2.5 Local Projects for Sustainable Development

Introduction

The "Local Projects for Sustainable Development" cross-cutting theme intends to contribute to the economic and social development of local communities through scientific research, applied research and advanced training and dissemination initiatives. The activities take place in agreement with the territory, in collaboration with local public and private institutions. There is a constant dialogue between FEEM and the key actors of the territory for achieving the common goal of sustainable local development.

Research activities are developed in the following areas:

- *Environment and Energy*
- *Economic Analysis*
- *Sustainable Tourism for Local Development*

The main characteristics of this theme are that it has a multidisciplinary team. Since the activities are based on issues related to energy, environment, tourism, sustainable local development projects, higher education and dissemination, the team is made up of various qualified members covering all the necessary competences areas of expertise.

Research

2.5.1 Environment and Energy

The energy and environmental research group will develop research projects of experimental kind related to environmental variables (water, air, soil and sediments) and ecosystems. The activities will be carried out in collaboration with the main local Research Bodies and the local Authorities, with the objective of delivering concrete, high impact projects for encouraging the development and sustainability of the territory. The activities planned for the coming years are directly related to the objectives of Agenda 2030 for Sustainable Development, in particular: Quality of Education (SDG4); Clean water and sanitation (SDG6); Cities and sustainable communities (SDG11); Climate action (SDG13); Life under water (SDG14); Life on earth (SDG15).

The activities in the next three years will be:

Environmental quality of the Agri Valley.

Research, policy relevance/support and social impact: The parameters related to environmental variables will be collected to offer a complete and integrated picture of the environmental quality of the Agri Valley. This quality assessment should offer benchmarks for a better understanding of the impacts of the phenomena and, at the same time, it should offer a useful methodological approach to be exported elsewhere.

Study the influence of climate change on the quality of water and sediments of the Pietra del Pertusillo lake (Agri Valley).

Research, policy relevance: The response of geochemical records in lacustrine sediments and water to climate and human activity will be examined. The goal is to provide a scientific instrument of policy support and social impact. The sharing of the results with local government bodies will be used as a starting point to program useful policies, also based on what is already required at the national and community level.

Ecological and socio-economic impact of invasive alien species on the management plan for the National Park of the Lucan Apennine's ecosystem.

Research, policy relevance/support and social impact: We will work in collaboration with the National Park of the Lucan Apennines to protect native biodiversity and ecosystem services of Lake Pertusillo by developing an alien species management plan. Invasive alien species are animals and plants that are

introduced accidently or deliberately into a natural environment where they are not normally found, with serious negative consequences for their new environment. They represent a major threat to native plants and animals in Europe, causing damage worth billions of euros to the European economy every year (European Commission).

Assessment of the organisms' adaptive capacity: The case of historical oil seepages in Tramutola.

Research, Training and Knowledge dissemination, Policy relevance, Entrepreneurship development: FEEM intends to set up a research project to understand if and how the natural ecosystem has adapted to the presence of hydrocarbons that naturally leak out of the ground. The aim of this research is to identify high-performing native species potentially capable of degrading hydrocarbon mixtures. The identification of natural micro-organism communities will increase know-how and the possibility of success for green strategies for remediation of the various environmental matrices. These studies arouse great interest among specialists in the field, but also among public administrators who must find systems that are economical, sustainable and with a low environmental impact in the field of remediation of contaminated sites. From a social point of view, and in consideration of the territorial peculiarity and the historical importance of the Tramutola site, scientific awareness projects fit in well with the series of sustainability activities that FEEM is conducting in Val d'Agri, combining research and innovation.

Development of the management plan for a lake ecosystem preservation.

Research, Training and Knowledge dissemination, policy relevance/support, social impact, Entrepreneurship development: The aims of the project will be to implement actions to re-establish the water reservoir functionality of lakes that are subject to eutrophication, according to the European Union's environmental policy and legislation on surface water quality. In particular this means applying an integrated management of nutrient loads and organic pollutants to the water resource in order to mitigate and control the eutrophication process; to prevent seasonal algal bloom and lake eutrophication; to re-establish the ecological functionality of lakes; to provide the European States with tools to improve the management of water resources at the national and local level by special replicability plans to ensure the dissemination of results.

Training and knowledge dissemination

FEEM will be involved in the conception and design of educational packages on energy, sustainability and sustainable tourism. The aim will be to disseminate knowledge in an innovative and effective way on the territory in cooperation with local and private institutions. The dissemination and training activities will consist of: realization of training courses; projects promoting new forms of teaching in schools; paths of higher education in the environmental, administrative and energy sectors; development of an Environmental Biomonitoring Center which will be a socio-cultural attractor and possible efficient way to connect schools, companies and research institutes (work experience).

Third mission: policy relevance and support and social impact and business development

As for policy relevance and support, social impact and business development, this cross-cutting theme intends to support Local Authorities in applying the appropriate policy and management approaches to the event "Matera European Capital of Culture 2019" by taking into account not only the specific context but also the perspective of the Sustainable Development Objectives set in the COP21 and Agenda 2030 Agreement. The event "Matera European Capital of Culture 2019" can thus be considered as a case study for elaborating and testing new methodological approaches that can help the integrated and sustainable management of the resources and that can be adjustable to the dimensions of relatively small areas. The effects on local areas will be estimated through the identification of specific indicators and by using methods and forecasting instruments never applied before on the territory. The results of the study will make it possible to estimate the impacts on the local economy and population. Another important aspect

of the project will be to disseminate the study results to the public and private stakeholders, as well as to the general population.

2.5.2 Economic Analysis

Previous studies by FEEM in this area were conducted mainly in the Basilicata region. All the analyses moved from an in-depth study of the territory through a careful investigation of its main variables: demographic and industrial sectors, business and tourism activities, household income, etc.

The detailed study of territorial variables is useful for identifying interesting phenomena and estimating their impact on local economy and employment. These studies are designed to assess the impact of phenomena and also to make predictions and elaborate scenarios to estimate the future impact of certain events related to the economy of the territory. The main mission of this research group is to find the most innovative and cutting-edge methodologies to study the local economy, to find the most updated and meaningful data, but above all to carry out economic and social studies with the purpose of supporting the public and private sectors on issues related to local socio-economic development.

For the next three years, the purpose will be to develop a model of analysis, impact assessment and forecasting with a view to supporting public and private institutions to gain a better understanding and interpretation of the key variables of the territories of interest. In three years FEEM will become a key reference player in helping institutions to monitor the local economy and understand the impact of various phenomena. The reference area in which FEEM is already operating will be used as a testing laboratory and then as a case study to expand the model to the entire Italian territory. In order to achieve this target, the research team needs to collect sound databases, develop and test a system of indicators and impact assessment models, and set up dashboards and dissemination activities for the final users.

More specifically, the team will carry out the following research activities:

- Monitoring local socio-economic variables
- Monitoring the monetary and occupational impact on local development of the oil and gas industry
- Set up of comprehensive local database with standard techniques and experimental techniques such as crawling and scraping of web and social data.
- Setting up and testing new models of the impact assessment of local phenomena
- Setting up and testing a local sustainability index in order to gain a better understanding of all the local development components
- Setting up a simulation model that, starting with local data, assesses the impacts and scenarios of given input variables
- Setting up the architecture of a local dashboard with all the data and models visualized according to a data visualization standard, which helps monitor all the variables of a given territory.

Training and knowledge dissemination

Research activities will lay the groundwork for another essential goal of the team: knowledge dissemination. All the research results are intended as an asset for the community. Workshops will be organized in order to get local actors involved in the methodology and to collect suggestions. It will be important to establish partnerships with local institutions (Bank of Italy, territorial units of ISTAT, the University of Basilicata and local institutions), as data will not be collected only in an automated way by using the web. This aspect is of great importance since data sharing is one of the knowledge transfer aspects. Moreover, the research team will build the models that will study the territory together with institutions in such a way that they do not overlap with the work already done by local institutions, but are complementary to them. Lastly, the entire methodology and the final results will be shared with the local population and the students through training activities, workshops and meetings. This will lead to a better

understanding of the territory and will also set in motion a virtuous cycle in which citizens demand data to understand the territory and make suggestions on the basis of that.

Third Mission: policy relevance and support

The Local Project cross-cutting theme provides valuable support to the public and private sectors in order to gain a better understanding of the territory and trigger an evidence-based policy making process. The actual challenge of this cross-cutting theme is to get this process started: in a world where there is an abundance of data but - especially at the local level - a lack of systematic organization and - above all - scarce consultation and interpretation of data in making decisions, the path envisioned by FEEM could be a very valuable support to the policy-making and governance of local institutions.

Third Mission: social impact and business development

The social effect of this cross-cutting theme in the next three years will be significant. The new vision of the territory given by this model will help to improve the quality of public and private decision-making processes. Decisions deriving from these processes will have an impact on the civil society, which will be empowered by the Local Projects' dissemination activities and can truly impact on the decision processes and be an actual partner of institutions and local players.

2.5.3 Sustainable Tourism for Local Development

Governance and tourism planning

Setting up a balanced governance in the tourism industry is essential for its enhancement, especially in Basilicata and to take advantage of all the still unexplored possibilities. In this general framework, quantitative and qualitative analyses become essential for planning such a complex system as tourism.

- Matera 2019: promotion and development of the regional tourism system

  The goal is to define a strategy to integrate, as a touristic destination, the appointment with the European Capital of Culture in 2019 – Matera with the remaining territory of Basilicata. This strategy would expand the benefit throughout the region and enable the entire community to benefit from this great promotional and development opportunity. The main action of this research project is to elaborate an action plan and make it available to local administrations and other institutions in the network.

- Basilicata experiences: the impact of great attractors

  The study aims to assess the effectiveness of the investments made in these years for creating a system of great attractors in Basilicata. The evaluation will be made on the basis of the change in positioning and reputation of the Region as well as the economic and tourism impacts on the territory. Moreover, the research will analyze the existence of network policies between these great touristic attractors and the feasibility of an integrated experience among them.

- Archaeological heritage and cultural tourism in Basilicata

  This research is part of a broader project approved by the Regional Council and aims at protecting and promoting the archaeological resources of Basilicata, through the study of its entire ancient road network. The methodology undertaken in this research study is mixed and will include research on historical and topographical sources as well as the use of the latest technologies (virtualization, augmented reality, GIS) for the planning and use of cultural heritage sites.

Tourism and innovation

The disruption that has affected the tourism industry is due to the profound changes related to the digital transformation of the economy and interaction among users. This research area aims to understand how the tourism sector of Basilicata can exploit the advantages of these changes to improve the position of Basilicata in the international arena.

- New technologies applied to the promotion of itineraries

  The research objective of the regional project South Culture Routes, which will start in 2017, will be to set up of a network of cinema-themed itineraries that exploits the potential of new technologies to direct the flow of tourists from the more frequented areas to those off the beaten track.

- Entrepreneurial innovation in tourism: needs analysis and training activities

  This research, in line with the studies conducted in 2016 in collaboration with the Unioncamere Study Centre of Basilicata, intends to investigate the skills of local tour operators, verify the effectiveness of training programs already undertaken by companies, clarify the expectations of tourist industry managers in order to identify critical areas on which to develop a plan for training managers and entrepreneurs in the tourism sector.

- Relaunching the internal area of Basilicata to counter the depopulation crisis

  The research objective is to analyze the depopulation of small towns of Basilicata and elaborate policy proposals on how to build a framework that would favor counter-urbanization phenomena. One of the goals is to attract the so-called “Lifestyle Entrepreneurs,” businessmen attracted by rural environments and interested in relocating to and investing in these areas.

Tourism and sustainability

How to combine tourism and sustainability? How can we mitigate the negative impacts of tourism? To answer these questions and identify suitable strategies to ensure the delicate balance between human activities and sustainable development it is essential to make an analysis of best practices and innovative models of development. The case study as a research method is important for theorizing the concept of sustainability based on direct experience.

- Analysis of social reporting models in protected areas

  As part of the research PARCO (Protected Areas sustainability Reporting and Communication Program), the goal of this research project is to monitor the sustainability report and the methodology adopted by Italy’s protected areas. This activity will complement the study of the social reporting project undertaken by Basilicata’s National Park of Val d'Agri Lagonegrese.

- Food&wine tourism in rural area: from product brand to territorial brand

  The enhancement of food and wine can be a path for sustainable development of the territory. The main objective of this research is to define a single brand for all quality products in a way that communicate the rural dimension of Basilicata. The research project will analyze all the operational and strategic tools that can support public and private programming in the rural tourism sector.

- UNESCO’s Chair on “Mediterranean Cultural Landscape and Communities of Knowledge”

  The four-year university chair on the “Mediterranean Cultural Landscape and Communities of Knowledge” has been approved and granted to DICEM of Unibas (Matera). The UNESCO Chair will support training on topics such as sustainable tourism, tourism in protected areas, and the potential of archaeological and rural tourism.

Training and knowledge dissemination

One of the aims of the research is to support public and private stakeholders both to gain a better understanding of the dynamics in which they are involved and to facilitate the process of changing work methods and enhancing creative processes. The actions undertaken in this area will be realized, both in the research and final phase, through seminars, workshops and focus groups with actors from time to time involved in the projects (Matera 2019, Federparchi, Parks Authority, Local government, managers and entrepreneurs, etc.).

Third Mission: policy relevance and support

The main mission of the research team is to support decision-making bodies in the tourism sector in their strategic planning and in implementing operational activity processes. The group will work closely with local authorities, such as the Basilicata Region, the Tourism Promotion Agency, the CNR and the Lucania Film Commission. In addition to supporting programming activities, the team will also support the preparation of European financing tenders for the 2014-2020 programming period.

Third Mission: social impact and business development

The most important goal of the work of FEEM's Local Projects team is to promote an integrated approach between tourism products and the territory. Only in this way will it be possible to create value for both the private sector and the territory. For this reason, this research group promotes actions that bind the most frequented tourist areas of Basilicata to the weaker ones, through actions that contribute to the knowledge of the territory, especially its archaeological and gastronomic heritage. Enhancement of localism, concertation with actors and enhancement of the right conditions for developing the region and supporting private enterprise.

3. INTERNATIONAL CENTER FOR CLIMATE GOVERNANCE (ICCG)

Introduction

The International Center for Climate Governance is a joint initiative of FEEM and the Fondazione Giorgio Cini. It is a tool designed to transfer knowledge produced by the research programs and cross-cutting themes to a wider non-specialist audience. Its role is to carry out policy analyses, link up with other think tanks working on climate change and sustainable development, and stimulate new ideas and practical solutions to tackle the climate change problem, particularly in developing countries.

Moving towards the objective of containing the rise of global temperatures entails important challenges in all sectors of our societies and requires the involvement of different actors who must necessarily work together to build a more sustainable world. National and international climate policies are crucial elements for guiding the needed change, and only an effective climate governance can allow countries to reach the targets jointly defined under the Paris Agreement. Nevertheless, effective governance must be supported by scientific research on the one hand, and by the approval of citizens and grassroots ideas and practices on the other.

In order to help prepare society and policymakers to address this urgent issue, and with the twofold objective of (i) specializing on policy analysis, and (ii) enhancing the dissemination of its research output to reach a wider public of civil servants, policymakers, business leaders, government officials, etc., FEEM has developed a special initiative: the International Center for Climate Governance (ICCG) was founded in 2009 as a joint initiative of the Fondazione Eni Enrico Mattei and the Fondazione Giorgio Cini, with the support of the Italian Ministry of the Environment. The ICCG is now an internationally renowned brand, whose wide range of activities focuses on the design of climate policy and related governance issues.

ICCG favors the interaction between political scientists, economists, policymakers and business leaders to analyze the interdependencies between the economic, social, cultural, ethical, and political dimensions of climate governance.

The ICCG's mission is to disseminate scientifically-based socio-economic research in the fields of climate change mitigation and adaptation to policymakers, business leaders, academics and the general public. It seeks to achieve this at the local, national and international levels through interdisciplinary activities as well as through the production of climate and energy policy analyses and definitions of optimal governance models for climate change management.

In the light of its previous successes, ICCG now aims to strengthen its authority in the arena of climate policy studies and dissemination in the coming years by pursuing an increased coordination and integration with the activities carried out by FEEM's research programs.

Research

ICCG's research activities are mostly organized through three interdisciplinary observatories on specific aspects of climate governance. Thanks to their dynamic features, they facilitate users' access to information. The ICCG observatories, which will be improved in an ongoing manner in order to further expand their area of influence are as follows.

Climate Policy Observer (climateobserver.org)

An observatory on climate policy worldwide and, at the same time, a platform providing information on negotiations and domestic implementations of climate related policies. It is meant to keep up with current climate and energy policy issues: users (mostly non experts) can find the latest news, get information and data about what countries around the world are doing to face the climate challenge, and can access scientific and official publications. It produces a weekly newsletter, as well as daily web-news.

Best Climate Practices (bestclimatepractices.org)

An interactive platform that collects a selection of practices that deserve attention for their originality, positive impact in dealing with climate change, implementation potential and replicability at the local, regional, national and global level. Best Climate Practices gives a complete overview of concrete actions for dealing with climate change while stressing the wide range of possibilities that, if implemented by politicians, economists, institutions, enterprises and researchers, could make a decisive difference. The project organizes an annual contest that awards prizes to practices that demonstrate the greatest innovation and replicability potential. Anyone can get actively involved in the development of the platform by submitting new practices at any time and rating the best ones at the time of the yearly contests.

Think Tank Map (thinktankmap.org)

A worldwide observatory that provides an overview of think tanks active in the field of climate change governance. Its interactive map shows the organizations that are working in the main fields related to climate governance worldwide, it highlights their projects and current activities and explores their interaction with other organizations and their influence on policy. With the aim of recognizing the excellence of the main institutions addressing climate issues, the ICCG has published a ranking of the best think tanks active in the field of climate change economics and policy every year since 2012. The ranking takes into account the quality of a think tank in conducting research and its role in influencing climate and energy policy. The ranking is built on a new method for evaluating think tanks by using a composite index that describes the three main pillars of a think tank: activities, publications and dissemination. The think tanks included in the map are constantly growing and are ranked each year.

Training and knowledge dissemination

The three observatories are not only the core of ICCG's research but are also catalysts and showcases of its various dissemination activities (contests, events, videos, web contents, etc.) which will continue to be carried on under their umbrella in the coming years.

In addition to the dissemination activities strictly connected to its observatories, ICCG organizes a wide range of dissemination activities targeted to different publics.

Knowledge dissemination means targeted to a specialized public include:

- The organization of scientific events of international relevance: lectures, seminars, workshops, conferences, and policy sessions in major international events;
- Director's blog (carlocarraro.org), which presents expert analyses of the most recent events and hot topics concerning climate change;
- A collection of e-publications that aim at supporting research and fostering international understanding of climate change issues. ICCG e-publications include:
    - International Climate Policy Magazine, a bi-monthly report that provides a clear analysis of climate policies and the worldwide evolution of the carbon market;
    - Reflections, a publications series which provides insights into key climate change issues. Reflections concisely analyze current challenges related to climate and energy policies and show research results useful for stimulating further discussion.

Knowledge dissemination means targeted to the public at large include:

- Web-communication tools (websites, web-portals and social networks) for reaching the widest possible public;
- Cultural activities, such as art or photo exhibitions, contests, cultural debates, book presentations, and film festivals, characterized by an interdisciplinary and intercultural participation;
- Training activities targeted to students, researchers, entrepreneurs, policymakers and the general public;
- Video lectures, video interviews and webinars aimed at spreading knowledge to a global public thanks to the immediacy of this medium.

In addition to further developing the activities realized to date, ICCG will explore new forms of communicating research on climate change and of making the general public aware of the threats posed by climate change. In so doing, ICCG will be guided by thematic "Hot topics" and cross-cutting issues related to climate change, which due to their importance in the geopolitical balance represent global challenges on which the Center intends to focus its activities (e.g., in the past: the Arctic, Energy Poverty, Climate & Health, Water Security, Climate Finance).

Third Mission: policy relevance and support

Policy relevance and support are and will remain at the core of ICCG's mission and, therefore, will continue to guide all its activities. Disseminating climate research through an accessible language and making it available to a non-expert public through various communication means is fundamental for offering policy relevant contents on the topic of "climate change".

ICCG will continue to offer reliable information on climate sciences and policies for the Italian speaking public, offering most of its contents in two languages (Italian and English). This will help reduce barriers and knowledge/language gaps that hinder Italian policymakers, and in particular local authorities, in successfully addressing the climate change issue.

Moreover, when new reports by the IPCC (Intergovernmental Panel on Climate Change) are published, ICCG will develop a wide range of contents and initiatives to highlight and spread the most important policy relevant results (e.g., to be published in 2018, a special IPCC report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways).

Finally, ICCG will seek new ways to provide direct informative support to policymakers. With this aim, it will organize new initiatives involving policymakers and stakeholders, in order to maximize the involvement of sub-national actors and the private sector, relying on FEEM and ICCG networks.

Third Mission: social impact and business development

ICCG activities, mainly addressed to the world of policymaking and to the public at large, have important social impacts: on the one hand, they can help the world of policy to stay informed and stimulate the design of new and adequate climate policies; on the other, raising citizens awareness on climate change fosters their participation in climate activities and their support/acceptance of public climate policies.

In order to enhance this impact through its network, ICCG will foster and strengthen its partnerships and relationships with climate think tanks worldwide, and will expand the engagement of local, regional and international stakeholders, also thanks to the activities related to the Think Tank Map observatory.

Best Climate Practices (BCP) is expected to have important impacts both at a social and at a business level. The platform aims not only at giving visibility to the best practical ideas for addressing the problem of climate change, but also at offering creative people the financing information they need to kick start their concrete climate projects. This aspect of the observatory will be further developed to enhance and stimulate the birth of new projects, companies, businesses and collaborations working for sustainable development.

Finally, the social impacts of ICCG activities will be maximized as they will also support the dissemination of the results coming from FEEM's research programs.

Following the ICCG's Steering Committee recommendations, *the ICCG will further increase its fund raising efforts in order to launch new initiatives and develop its dissemination events*.