CELA - Network of Climate Change Technology Transfer Centres in Europe and Latin America

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Abstract — Based on experiences gained in the frame of the climate project CELA funded in the context of the European Commission ALFA III Programme, this paper focuses on networking and technology transfer in the field of climate change between Latin America and Europe to illustrate how higher education institutions (HEI) can contribute to sustainable socio-economic development in Latin America. The paper will provide evidence for the fact that, despite the fact that many Latin American states have given climate change adaptation a high priority, the same states often have neither the technology nor the resources needed in order to adapt successfully. Also, to cope with the many challenges climate change poses, the role of HEIs, especially in terms of research, consultancy and technology transfer as well as the capacity-building and qualification of human capital within the HEI and beyond, will be explored further. Finally, the paper will introduce a university-industry networking project which fosters the transnational transfer of climate change technology between Europe and Latin America and concludes by indicating some emerging themes which ought to be tackled to foster adaptation to climate change in this region.

Keywords — Latin American-European network, capacity-building, climate technologies, higher education institutions

1 INTRODUCTION

There is no doubt that the global climate is changing and will continue to do so in the future at rates projected to be unprecedented in recent human history. Agder [1] remarks that the associated risks of a changing climate are real, yet still highly uncertain; the author remarks that all societies are "fundamentally adaptive" [x: 179] and refers to past situations where societies successfully managed to adapt to climate change and similar risks.

Climate change is expected to affect both developed as well as developing countries substantially. Whereas developed nations tend to be more resilient to long-term environmental change, developing countries and their people are more vulnerable towards climate variability and change, as they have less capacity to cope with climate impacts. For this reason, developing countries need to increase their efforts and activities to raise their adaptive capacity outside their experienced coping range as to avoid negative impacts for their economies, the natural environment and their people.

Latin America represents a less developed region which relies heavily on its natural resources in terms of utilization. At the same time, the region is expected to be significantly affected by climate change [2], [3]. Despite the fact that many Latin American states have given climate change adaptation a high priority, the same states often have neither the technology nor the resources needed in order to adapt successfully. Moreover, promoting adaptive capacity in the face of competing sustainable development objectives is regarded as major challenge for adaptations in terms of local natural resource management to the scale of international agreements and actions [1].

In the face of these challenges, the role of higher education institutions (HEIs) - in terms of research, consultancy and transfer of climate change technology as well as the capacity-building and qualification of human capital within the HEI and beyond - will be explored further and a dedicated university-industry networking project will be introduced.

This paper is organized as follows: Part 2 addresses the impacts of climate variability and change for Latin America. Part 3 will then provide insights about the current state of adaptation to the previously discussed climate variability and change for the respective region. Part 4 briefly presents the generic North-South technology transfer paradigm and a complementary paradigm, elaborating on the key role of technology transfer for adaptation to climate change, followed by part 5 which introduces the CELA project as one example of a network approach to foster the transnational transfer of climate change technology between Europe and Latin America. Part 6 then concludes with a brief reflection of Latin American climate technology transfer needs and gives some recommendations for further action.

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2 Impacts of climate Variability and change for the Latin American Region

For Latin America, research findings from the last decade have provided sound evidence of significant changes in precipitation and temperature. Depending on the underlying emission scenario (SRES) and according to multiple models, the projected mean warming for the region towards the end of the century ranges from 1-6° C. With reference to precipitation, many general circulation models (GCMs) suggest more irregular rainfall for tropical regions and less anomalies for extra-tropical South America; also, extreme weather events and climate extremes are expected to become more frequent. Moreover, there is high confidence (about 8 out of 10) that sea-level rise, together with weather and climate variability and extremes will affect Latin America's coasts. Among the most serious impacts associated with the projected changes in climate, the following are mentioned in the literature: extinction of species and habitat loss; changes in vegetation cover, desertification and salinization; and the retreat of glaciers, e.g. in the Andean region. With reference to food security, agricultural yields for selected crops, e.g. rice, are likely to shrink or increase, e.g. soy beans, whereas estimated impacts on other crops are less predictable, depending on the scenario chosen and the consideration of CO2 effects. Concerning societal impacts, future population increase within the region combined with reduced water availability may lead to serious water stress for up to 150 million people in Latin America. Not considering CO2 effects, the risk of hunger may increase substantially, impacting 26 million persons by 2050 and 85 million by 2080, with a declining cattle and dairy productivity worsening the situation [4: 583-584].

3 Current State of Adaptation in Latin America

Whereas previously the main climate policy focus relied on promoting particular adaptation options, efforts nowadays focus on strengthening the adaptive capacity which refers to "increasing the ability of individuals, groups, or organisations to adapt to changes, and implementing adaptation decisions, i.e. transforming that capacity into action" [5: 78] to deal with uncertainty in today's climate projections [6], [7].

Eakin and Lemos [8] refer to the growing scientific consensus on a range of generic factors which are viewed as building adaptive capacity: free flow of ideas, knowledge and technology, more flexible and efficient government and and governance schemes, policies fostering social and political capital as well as building human capacities, and a fairer distribution of resources [6], [7], [9].

Eakin and Lemos [8] also emphasize the importance of interaction between decision-makers, stakeholders and institutions from various governmental levels for raising the adaptive capacity of a system, or in this case a nation.

Magrin et al. [4: 603] reports that some Latin American countries are starting to adapt to the changing environment, focusing, for example, on setting up risk reduction measures such as early warning systems, designing flood/drought/coastal management strategies or ensuring better protection of their ecosystems. Yet these actions seem to be outpaced by reality which is characterized by not only limited knowledge on and perception of climate change, lack of financial and human resources and low awareness of climate change at particularly the political level, but also by missing data and information, lack of capacity and adequate regulatory frameworks, low income levels, people living in vulnerable areas etc. [4], [10].

Drawing from the EuroCLIMA assessment of climate change in Latin America, Appendix A provides an overview of the current state of adaptation in selected Latin American countries [10: 50-81. Concerning mainstreaming, climate change legislation in the Latin American region is rather new: most countries mentioned introduced their national strategies during the last decade.

The overview also indicates that all countries which value mitigation have implemented popular initiatives accordingly, such as the Clean Development mechanism (CDM) or Reducing Emissions from Deforestation and Degradation (REDD) projects (see Appendix A). Yet even though adaptation – sometimes indirectly referred to by means of related themes e.g. biodiversity, soil degradation or desertification –, may be recognized as one of a range of national priorities, only very few countries seem to have tackled the challenge of implementing adaptation in practice.

More efforts and resources seem to be needed to be made to mainstream adaptation to climate change and align corresponding policies and processes with national development objectives. The following chapter will explore how an improved transfer of climate change technologies may contribute to this and illustrate by means of a recent development aid project in Latin America one way to addresses this challenge.

4 The International technology transfer Of Climate Change technologies

4.1 Defining international technology transfer

According to the literature, the term 'technology transfer' (TT) has over time evolved from a rather narrow definition referring to rather *tangible* items e.g. computer hardware to a broader terminology which includes intangible elements of organizations, so-called *tacit* knowledge, i.e. knowledge that is embedded in people and processes [11: 420]. Moreover, technology transfer mechanisms can be distinguished according to formal or informal nature:

- Formal: licenses, research joint ventures, and university-based start-ups, technology transfer offices etc. (see for example [12], [13], [14], [15];
- Informal: knowledge transfer, joint publications with stakeholders from industry, consulting etc. (see for example [16], [17].

Bercowitz and Feldman [18] critically remarks that most research on technology transfer still take a limited view and analyzes formal mechanisms only, whereas the importance of informal mechanisms in university-company relations as well as further economic, social and political influencing factors are not factored in. In line with this, even if formal mechanisms have been implemented, these may be circumvented due to various reasons [19].

4.2 Technology transfer paradigms

According to Brewer [20], the international discourse on technology transfer (TT) is features mainly North-South technology and financial flows, e.g. in the frame of bilateral and multilateral development aid or CDM projects; this situation is reflected in a vast range of multilateral documents and agreements produced in the course of global climate change agreements, e.g. article 4 of the UNFCCC or the Bali Action Plan.

It is criticized [20] that the prevailing TT paradigm falls short of considering the importance of trade and foreign direct investment (FDI) as main mechanisms for international technology transfers which may allow to better seize the potential of international TT for climate change mitigation and adaptation. Brewer: [20] proposed a complementary paradigm which takes into account that technology transfer may not only work in a North-South direction, but instead refers to evidence of TT among groups of countries, from developing to developed nations and among developing countries as well. In this respect, several developing countries are regarded as world leaders in a range of climate-friendly technologies, e.g. South Africa in coal-to-synthetic-fuels, Mexico in solar hot water heaters, China in coal gasification and photovoltaic, India in biofuels and wind energy etc. [21], [22].

4.3 Characterizing the university-industry transfer of technologies

Link et al. [19] suggest that socially constructed networks which allow TT between all parties may represent an important mechanism for university-industry technology transfer processes. Such networks may comprise academic and industry scientists, university administrators, technology transfer officers as well as entrepreneurs [23], [24].

At the heart of university-industry-relationships are transactions that may occur e.g. in the frame of sponsored research, licensing agreements, hiring research students, start-ups,or simply by chance [18].

Providing technological know-how for industry has been one of the classic roles of universities; lately, Bercowitz and Feldman [18: 175] observed increasing university-industry collaboration due the following interrelated developments:

- The growing share of scientific and technological content with reference to industrial production
- The development of new technology platform such as computer science, molecular biology, material science;
- The need for new sources of academic funding due to university budget constraints
- New government policies stimulating university technology transfer to generate positive returns on investment in public research

Yet due to different strategic orientations and a general lack of mutual trust, successful technology transfer is viewed as a challenging task for the actors involved; even though a prerequisite, the sheer presence of an academic institution does not automatically result in the technology flows to foster economic development if motivations and incentives to act are missing [18], [25].

Bercowitz and Feldman [18] examined this "black box of university-technology transfer" further and identified several "points of influence and specific factors" [18: 176] which foster the generation and transmission of know-how, e.g. labor mobility, social interaction, local networks, and personal communication, all of which need to be considered in the context of the respective institutional environment with its characteristic governance, routines, norms and internal processes.

Adding a motivational perspective, Link et al.'s [19] empirical findings on selected informal TT mechanisms among 766 university staff members suggest that the gender, tenure of staff and the active involvement in research grants determines the motivation to engage in informal knowledge transfer, in this case knowledge transfer, writing joint publications and consulting.

Moreover, a 2004 study on TT through disclosing inventions suggests that the motivation of university staff is influenced by the following: training effects, leadership effects, cohort effects. If an institution has a history of TT, if its leaders are actively supporting TT and if peers are also disclosing inventions, then the participation in TT in general seems to increase [18].

Concerning individual barriers to engaging in commercialization of research, Bercowitz and Feldman [18: 180] refer, for example, to national culture and academic socialization which may influence the motivation to engage in TT. Other studies found that the TT may be mostly influenced by faculty reward systems, staffing and compensation practices, but also cultural barriers between universities and industry [26], [27].

4.2 Introducing climate change technologies

Concerning the actual technologies, a range of lists on goods and services relating to climate change have been published. For example, and reflecting the prevailing carbon reduction perspective of many Latin American countries, the Expert Group on Technology Transfer of the United Nations Framework Convention on Climate Change (UNFCCC) provided a comprehensive list of green-house gas (GHG) mitigation technologies which may lead to enhancing the implementation of the global framework for climate change [28], [29], [30].

According to the previously mentioned UNFCCC list, mitigation technologies can be distinguished with reference to the following categories and disciplines:

i. <u>Reducing emissions from energy supply and infrastructure</u> (low emission, fossil-based power and fuels, hydrogen, renewable energy fuels, nuclear power, and energy infrastructure);
ii. <u>Reducing emissions from energy use</u> (transportation, buildings, and industry);
iii. <u>Enhancing capabilities to measure and monitor emissions</u> (hierarchical measuring and monitoring systems for energy efficiency, geologic carbon sequestration, terrestrial carbon sequestration, ocean carbon sequestration and other greenhouse gas);
iv. <u>Reducing the climate effect of non-carbon-dioxide greenhouse gas</u> (methane emissions from energy and waste, methane and nitrous oxide emissions from agriculture, emissions of high global-warming potential gasses, nitrous oxide emissions from combustion and industrial sources, and emissions of troposheric ozone precursors and black carbon)

In contrast to this exhaustive list of mitigation technologies, Brewer [20] finds that adaptation technologies appeared to be less systematically researched and promoted; this may suggest a rather lower level of interest by researchers to assess these technologies. Accordingly, the UNFCCC expert recommendations on technology transfer [only provide some illustrative technologies for adaptation, referring to either spatial properties such as coastal zones or sectors such water, agriculture or health. The following technologies are indicated by UNFCCC [31]:

- Coastal Zones:
  - Hard structures-dykes, sea walls, tidal barriers, detached breakwaters;
  - Soft structures-dune or wetland restoration or creation, beach nourishment
  - Indigenous options- walls of wood, stone or coconut leaf, afforestation
- Water Supplies:
  - Increase reservoir capacity
  - Desalinate
  - Improve soil conservation
- Agriculture:
  - Change tilling practices
  - Build windbreaks
  - Line canals with plastic films
- Health:
  - Early warning systems for heat waves
  - Improved public transport

This list of adaptation technologies is by far not exhaustive and may in the future become amended as global adaptation efforts progress.

5 THE CELA PROJECT - A NETWORK APPROACH TO FOSTERING CLIMATE CHANGE TECHNOLOGY TRANSFER BETWEEN EUROPE AND LATIN AMERICA

Linking theory with practice, the following development aid project may serve as an illustrative practice example how international transfer of climate change technologies and knowledge can supported through distinctive organisational structures, processes and activities:

The EU-funded project "CELA – Network of Climate Change Technology Transfer Centres between the EU and Latin America" (www.cela-project.net) addresses the need for better exchange and multilateral interaction over the next three years (2011-2013). The overall objectives of the CELA project are threefold:

(1) Fostering sustainable research and technology transfer cooperation between higher education institutions (HEI) in Latin America and the European Union
(2) Improving the quality of research and technology transfer of Latin American HEI
(3) Strengthening the role of Latin American HEI in the sustainable socioeconomic development

In this respect, the CELA project focuses on the thematic sector of Climate Change as both mitigation and adaption to climate change are contributing to supporting sustainable socio-economic development in Latin America. It does so by means of three key areas of activity:

(a) Setting up a dedicated networking infrastructure at the partner institutions;
(b) Linking academia with industry and politics through effective networking and brokering of information and cooperation in the field of climate change technology;
(c) Capacity-building among research staff in support of transnational technology transfer in the field of climate change technologies.

Setting up a dedicated networking infrastructure which is replicated at all project partner institutions resembles the backbone of the CELA project: These Climate Change Technology Transfer Centres (CTTCs) will be making better use of the science and technology knowledge existing in the participating regions, in setting-up local networks and establishing transnational contacts to intensify joint applied research in the field and between Latin America and Europe, in support of socio-economic development.

But the TTCs are also designed to fulfil another important function: As 'knowledge hubs' within the CELA network, they strengthen the link of European and Latin American research communities not only in the academic sense, but also beyond, i.e. with regional markets, business and legislation (policy) in the field of climate change. By closely linking especially the economic actors to the respective CTTc, these structures may support the development of a wider market-oriented European-Latin American network of Climate Change Technology Transfer Centres.

Since the prevailing lack of expertise and limited access to climate knowledge is still a major impediment to tackle the challenges of global warming, the project further entails capacity-building actions for the partnering research institutes and in particular their qualified research staff. The ultimate goal is to create an enabling environment for the occurrence of technology transfer by means of training staff and providing expert advice to stakeholders from academia, industry and politics.

CELA targets three distinctive groups to enable the exchange of expertise and knowledge transfer not only within the sub-groups but also among them:

- Researchers, teaching staff, administrative and management staff at participating research institutes
- Enterprises, private and public institutions in the field of climate change in participating countries
- Decision- and policymakers in participant countries in the field science and technology

In order to deliver the project activities as efficiently as possible, the tasks are structured according to six work packages ('Project management', 'Assessment of Needs, 'Research and Climate Change Technology Transfer Centres, 'Capacity Building', 'Evaluation and Recommendations', 'Networking and Dissemination'). This implementation method bears reference to achieving both long-term (e.g. market-oriented science and technology transfer, networking) and short-term (e.g. pilot projects, staff capacity building) impacts by providing replicable structures and procedures for spin-off projects.

Moreover, the implementation method of CELA aims at the close involvement and participation of the local stakeholders and target groups (enterprises, ministries, NGOs etc.) right from the start. Thus, the partners may create reliable and trustful contacts to future clients and cooperating partners for applied research and technology transfer activities.

Ultimately, is is hoped that the CELA project may assist efforts in Latin Americato provide a market-oriented research and technology transfer approach, complemented by establishing specific recommendations for the different countries of how to excel within their region and beyond.

6 CONCLUSION

This paper briefly reviewed the projected impacts of climate variability and change for the Latin American Region and the current state of adaptation in selected Latin American countries. Two main paradigms and a range of concepts relating to the international transfer of climate change technology were explored and two possible categorizations of climate change technologies were introduced. Linking theory with practice, it was demonstrated by means of a concrete project example how the international transfer of climate change technologies may be addressed in reality. In this respect, the following may be concluded:

- Firstly, Latin America will need to cope with future climate impacts; to tackle challenges it is necessary to improve the adaptive capacity within the region, on regional, national and local level and across all sectors of society.
- Secondly, fostering international technology transfer may be regarded as a promising mechanism to build and increase capacities in the climate change sector; in this respect, adequate starting points and influencing factors need to be identified and

both formal and informal processes must be analyzed closely to design appropriate solutions and overcome existing barriers that hinder the flow of knowledge and technologies between university, industry and vice versa.

- Thirdly, networks which allow TT between all parties may represent an important mechanism for university-industry technology transfer processes. The CELA project may serve as a best practice example for a transnational approach which seeks to foster climate change communication and improve the flow of climate change technologies between Europe and Latin America and vice versa.

In terms of further research, it may be interesting to analyze in more in-depth the governance aspects and key success factors of these kinds of 'inclusive' research-industry networks which involve stakeholders from various sectors and professional levels may be further explored. Moreover, more research in exploring the crucial role of national culture in facilitating or hindering technology transfer may be needed, especially with international actors of different cultural spheres being involved. Finally, as these network approaches emerge increasingly all over the globe, it may be interesting to compare the practices and performance across national boundaries.

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Appendix A. Overview of the status of adaptation in selected Latin American countries

Country	Miti-gation valued	Adap-tation valued	Nat. priority issues	Nat.CC Strategy	Adapt. mecha nisms	Mitig. mechanisms	
						CDM	REDD
CELA partner countries							
Bolivia	Yes	Yes	REDD, Adap-tation	Since 2007	Yes	Yes	Yes
Guatemala	Yes	Yes	Adaptation: health, food security, water resources, infra-structure; REDD	ENCC guidelines in preparation. Plans drafted 2 priority river basins (drought, flooding)			
Nicaragua	Yes	Yes	Adaptation of agricultural issues; all other issues	Since 2001. (2004 updated, but not official). Since, 2005, the second National Communications process has begun	Yes	Yes	No
Peru	Yes	Yes	Adaptation, mitigation, REDD	Since 2003	Yes	Yes	Yes
Other Latin American countries							
Argentina	Yes	Yes[1]	Mitigation and Adaptation	-	Yes	Yes	No
Brazil	Yes	No[2]	Deforestation, Desertification	Since 2008	No	Yes	Yes
Chile	Yes	No[3]	Environmental Education, Mitiga-tion, Adaptation, Int. Relations	Since 2006	No	Yes	No
Colombia	Yes	No	Adaptation, Mitigation	Under development	No	No	Yes
Costa Rica	Yes	Yes[4]	Mitigation, Adaptation	Since 2004	Yes	Yes	Yes
Cuba	Yes	Yes	Soil degradation, forest coverage loss, pollution, biodiversity loss and water shortages	-	Yes	Yes	No
Equador	Yes	Yes[5]	Mitigation, Adaptation	-	No	No	Yes
El Salvador	Yes	Yes[6]	Economic + social impacts of CC, identification of vulnerable ecosystems	Under development	Yes	Yes	No
Honduras	Yes	No[7]	Adaptation	-	No	Yes	No
Mexico	Yes	Yes	Mitigation, Adaptation, stage	Since 2006	Yes	Yes	No

[1] The majority of legislation, functions and coordinating organisms are decanted towards mitigation strategies
[2] Adaptation mentioned in its National Climate Change strategy, but no adaptation mechanisms implemented.
[3] Adaptation mentioned as one objective in Chile's National Climate Change strategy but no adaptation mechanisms implemented
[4] Main efforts directed towards mitigation.
[5] By Executive Decree 1815, issued on 1 July 2009, Climate Change mitigation and adaptation declared as a State Policy, yet implemented mechanisms decanted towards mitigation.
6 Within its 2009-2014 Government Programme, the Ministerio de Medio Ambiente y Recursos Naturales (MARN) has adopted Climate Change mitigation and adaptation as a priority policy issues.
[7] All projects currently implemented deal with mitigation (CDM).

			financing + planning of climate action				
Panama	Yes	Yes	Mitigation, Adaptation	Since 2004	Yes	Yes	Yes
Paraguay	n/a	n/a	Aid in implementing National Climate Change Plan	Since 2003	No	Awai-ting appro val	No
Uruguay	Yes	Yes	Adaptation	Since 2004	Yes	No	No
Venezuela	Yes	No	Biodiversity, climate change, public education campaign, effective portection for existing protected areas	-	NO	Yes	No

Source: [10], adapted by author.