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## RESEARCH ARTICLE

# Novel shapes of South–South collaboration: emerging knowledge networks on co-benefits of climate and development policies

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This paper analyses knowledge networks on co-benefits of climate and development. The world's most sizeable populations live in middle-income countries with emerging economies and growing emissions. This situation requires political intervention to facilitate economic growth, job creation and poverty eradication alongside efforts to control emissions growth. This interdisciplinary study draws on concepts and methods from sociology, political science, science and technology studies and the management literature. The authors combine social network and discourse network analysis in an innovative way. The methodology analyses both the interactions between researchers as well as their actual knowledge contributions. The study argues that there is a substantial network of knowledge holders involved in knowledge creation on climate and development co-benefits. Our analysis shows the type of interactions between two knowledge networks as well as new knowledge emerging from these networks. Research groups and practitioners have produced 17 novel knowledge contributions, ranging from definitions of co-benefits, methodology and implementation. Yet the networks remain loosely connected. Practitioners who have less time to assess academic literature could benefit from closer interactions with more academically oriented experts and vice versa.

**Keywords:** climate change; co-benefits; knowledge networks; middle income countries; sustainable development

## 1. Introduction

Most of the world's poor live in middle-income countries with emerging economies and growing emissions profiles (Sumner, 2010). This situation requires the integration of developmental and climate change policy objectives (Wlokas et al., 2013). But do we know how to do this?

Researchers and practitioners in climate and development around the world are trying to solve the problem of how to reduce emissions and advance socio-economic development at the same time. Research on the matter has been codified in a small body of literature. The term “co-benefits” refers to impacts of climate change policy on human development and vice versa. The latest Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC, 2014) has appraised the literature on co-benefits. AR5 reflects the complexity of the concept and the uncertainties that come with assessments of co-benefits. It defines co-benefits as

Positive effects that a *policy* or *measure* aimed at one objective might have on other objectives, without yet evaluating the net effect on overall social welfare. Co-benefits are often subject to *uncertainty* and depend on, among

others, local circumstances and implementation practices. Co-benefits are often referred to as ancillary benefits. (IPCC, 2014, p. 1257)

The IPCC reports capture large parts of the explicit research into co-benefits that went through academic peer-review processes up to 2013. The tacit knowledge on co-benefits of climate change and development has not yet been systematically examined. Tacit knowledge refers to the knowledge that is bound to people and has not been made explicit in written form. Explicit knowledge, which refers to codified knowledge in numbers or writing, relies on tacit knowledge to be applied and understood. The two knowledge forms are closely related (Polanyi, 1966). This paper analyses knowledge networks on co-benefits of climate action, including the tacit dimension. The paper focuses on knowledge networks in the global South, because integrating climate and development policy matters to middle-income countries with growing emissions and persistent poverty levels. We analyse a knowledge network that emerged through collaboration among six middle-income countries in the course of a climate and development planning programme (Mitigation

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Actions Plans and Scenarios [MAPS]) between 2010 and 2015.

The analysis adds to the literature in applying well-established concepts of networked knowledge production from the corporate management and innovation literature to one of the world's most pressing public policy problems: integrating climate change and development. This research focuses on knowledge creation, not adoption or transfer. The following section establishes the background on knowledge creation in the research literature. Section 3 suggests a theoretical framework based on the literature review. Section 4 explains the methodology of social and discourse network analysis (DNA) in more detail. Section 5 presents the analysis in two parts: Firstly, the social network analysis (SNA) shows how several research groups interact to create tacit and explicit knowledge on co-benefits; Secondly, a DNA demonstrates the various thematic knowledge contributions on co-benefits. We conclude with a few recommendations on how knowledge networks can be tightened towards more efficient outputs.

## **2. Knowledge creation in networks: background and gaps in the literature**

The research literature on knowledge creation suggests that knowledge emerges through networks. Knowledge creation, adoption and transfer depend on the way individuals and organizations interact with one another. Knowledge networks have been defined as the collaboration between two or more actors with the strategic purpose of creating or using new knowledge, enabling interactive learning between the knowledge workers (Kreis-Hoyer & Grünberg, 2004; Phelps, Heidl, & Wadhwa, 2012). Information entering the knowledge network connects with existing knowledge, transfers between the knowledge workers, and eventually creates new knowledge outputs (Kreis-Hoyer & Grünberg, 2004). Knowledge creation has attracted the interest of researchers in several disciplines. The most significant bodies of literature have emerged in the fields of economics, management, innovation and sociology. The literature distinguishes between individual networks (ego-networks), intra-organizational networks (mostly inside a firm) and inter-organizational networks (relationships between two or more organizations).

The management literature focuses mainly on companies, intra-firm networks, and relationships between scientific and business organizations. The innovation literature emphasizes the role of public sector actors in close interaction with corporate and scientific organizations (Etzkowitz & Leydesdorff, 2000; Lundvall, 1992; Nelson, 1993). Literature from the social sciences, especially sociology, attempts to explain changes in knowledge production at a larger scale within nations and societies. New theories on the modes of knowledge production (Gibbons et al., 1994), the relationship between humans

and technologies (Latour, 2005), the role of strategic research in society (Rip, 2004), and systemic ways of knowledge production and innovation, attempt to grasp new dynamics and network characteristics in knowledge creation (Hekkert, Suurs, Negro, Kuhlmann, & Smits, 2007; Lundvall, 1992). Evidence is typically extracted from knowledge networks in industrialized economies. Innovation studies increasingly investigate innovation dynamics in developing countries, assessing knowledge creation from the perspective of networked learning (Globelics, 2015).

The literature in development studies on global knowledge networks emphasizes the importance of global knowledge networks for advancing socio-economic development in poorer countries. This literature promotes the role of knowledge networks as a funding instrument for donor agencies rather than offering any specific analysis of knowledge networks (Stone & Maxwell, 2005).

The literature on public policy also offers considerable insight into the role of networks in public policy decision-making. Network analyses of discourse and advocacy coalitions are integral parts of the literature on public policy. Ideas and beliefs are important ingredients for the formation of advocacy coalitions (Sabatier, 1988) and legitimate policy outputs (Beetham, 1991). Network analysis has been mostly applied to explaining policy outcomes, but less for policy learning (Rose, 2005) and evidence-based policy-making (Pawson, 2002; Solesbury, 2001).

Attempts to increase the use of knowledge in public policy decision-making have served two purposes: first, to incentivize research that helps solve real-world problems; secondly, to achieve better informed public policy decision-making (Niederberger, 2005). These attempts should evolve together (Kuhlmann, Shapira, & Smits, 2010; Lövbrand, 2011). The literature on evidence-based decision-making has not, however, fully benefited from the insights of the management and innovation literature on networked knowledge creation. In return, the literature on evidence-based policy-making can add important insights on the role of public policy in incentivizing research and knowledge production on real-world problems. Phelps et al. (2012) argue in their assessment of the research literature on knowledge networks that understanding the influence of the institutional environment on knowledge networks and outputs requires further research. There may be an opportunity for linking insights from these two strands of literature.

A possible explanation for this gap is that there is less interest in knowledge-based decision-making in the public sector than the private sector. A frequently quoted statement of John Keynes is that "there is nothing a Government hates more than to be well-informed, for it makes the process of arriving at decisions much more complicated and difficult" (Keynes 1937 cited in Stone & Maxwell, 2005). Keynes' notion opposes the generally

accepted understanding of the purpose of knowledge networks in management and innovation literature.

How do knowledge networks operate without a clear economic incentive for knowledge production? The case of climate and development is tricky, because both the protection of the climate and measures for poverty reduction depend on public policy interventions. Few authors have explored the modes of knowledge co-production in climate change (Lemos & Morehouse, 2005; Ziervogel, Archer van Garderen, & Price, 2016). The literature on the provision of public goods establishes competition between multiple policy objectives, because public funding is limited (Kaul, Grunberg, & Ster, 1999; Stiglitz, 1999). The following section introduces a framework for the analysis of knowledge creation emerging from evidence from large businesses. We apply this framework to a new empirical area of knowledge creation: co-benefits in climate and development. This area has different characteristics to the business context in which the framework is typically applied, since only a few private actors, mostly in the consulting business, are involved in the knowledge network, which is otherwise dominated by academia and the public sector.

### 3. A theoretical framework for knowledge creation: from business to public policy?

The theoretical framework for the analysis explains knowledge creation through the interaction of knowledge holders, who can be individuals or organizations. A knowledge holder possesses both tacit and explicit knowledge. Explicit knowledge is codified, expressed in writing, which makes it accessible to others independently from engaging with the knowledge holder. Tacit knowledge remains embodied in people and can be difficult to extract. Tacit knowledge roots in an individual's experience, behaviour and values, and evolves over time.

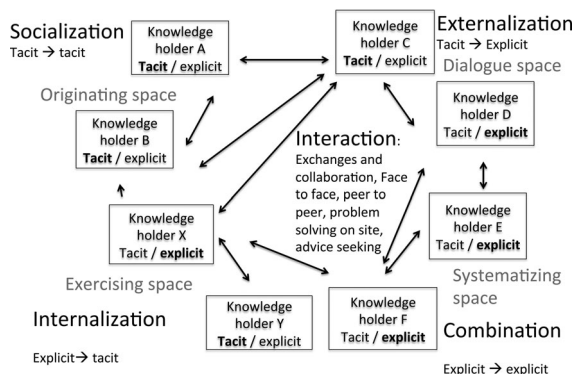


Figure 1. Analytical framework: processes and spaces for knowledge creation in networks. Source: Own compilation based on Nonaka et al. (2001) and Kreis-Hoyer and Grünberg (2004).

Nonaka, Konno, and Toyama (2001) specify the forms of interaction that matter for knowledge creation. Four forms of collaboration and spaces stimulate the creation of tacit knowledge as well as the combination or transfer of tacit into explicit knowledge and vice versa. The idea of spaces, or in Japanese *ba*, is an essential influence on knowledge creation. *Ba* can be both physical and virtual spaces and relates to the institutional environment in which knowledge creation is occurring. The four forms of collaboration and spaces for knowledge creation can be explained as follows:

Firstly, tacit knowledge creation occurs through the process of socialization, which refers to the “face-to-face” interaction of knowledge holders. This process allows the sharing of tacit knowledge, including feelings, emotions, ideas and worldviews. Such sharing contributes to building new tacit knowledge through human interaction. The space for this process, referred to as originating space, often stands at the beginning of a knowledge creation process.

Secondly, externalization and dialoguing refers to converting *tacit* into *explicit* knowledge. This space and process requires conscious decisions on the mix and capabilities of the team of knowledge holders to codify and extract tacit knowledge into explicit outputs.

Thirdly, combining explicit knowledge with new information leads to creating new explicit knowledge. This process can be referred to as systematizing, and can occur virtually.

Fourthly, extracting explicit knowledge from existing sources and internalizing them, contributes to the creation of new tacit knowledge (Nonaka et al., 2001). Explicit knowledge meets a reader, who builds tacit knowledge based on her own value system and existing knowledge base. This process, also referred to as exercising, may also occur in the beginning of a knowledge creation process along with socialization. Externalization and then systematizing occur at later stages. Figure 1 integrates Nonaka et al.'s (2001) contribution on spaces and phases for interaction of tacit and explicit knowledge holders with the interactive framework on knowledge networks from Kreis-Hoyer and Grünberg (2004).

The framework is fairly generic. Nonaka et al.'s concept of spaces emerged from corporate evidence based on an insightful case study on knowledge creation in Japan's 7-Eleven. Kreis-Hoyer and Grünberg's contribution emerges from evidence from inter-organizational knowledge creation between business and science organizations in Germany. In the following section, we test if the framework is applicable to structure the analysis of knowledge creation of co-benefits in climate and development.

### 4. Methodology: combining social and discourse networks

The methodology combines SNA and DNA. The combination of social and DNAs helps gaining insights into the

ways actors collaborate as well as the knowledge they create. SNA establishes the structure of the collaborative relationships in the knowledge network, whose nodes are the knowledge holders represented as individuals. The edges of the knowledge networks are relationships between the knowledge holders and their respective collaborators. The DNA combines SNA and discourse analysis. The idea of this paper is to establish a knowledge network about co-benefits in climate and development, and map the actors, as well as the “knowledge discourse”. The discourse network helps to extract the knowledge that was created through the interaction of the knowledge holders, and reflects the knowledge contributions on co-benefits of climate change and development that each actor brought into the network. The actors are coded as individual levels with a letter and number to distinguish individuals working at the same organization. The actors appear with this code and their affiliation, while remaining anonymous.

We chose to study the case of the Mitigation Action Plans and Scenarios (MAPS) programme. The research work on “co-benefits of climate change mitigation action” includes research teams and practitioners in six developing countries, namely Brazil, Chile, Colombia, Peru, South Africa and India. The programme encourages participative research and scenario-building processes towards integrating climate change mitigation and development perspectives. The research is problem-driven and focuses on domestic policy at the interface between climate and development. At the same time, the results are informed by domestic policy development and the international climate change negotiations under the Framework Convention on Climate Change of the United Nations (UNFCCC). The scenario-building processes ran in the Latin American countries, while the researchers in South Africa played a supporting and collaborative role. The Indian research group engaged in a specific research project on co-benefits.

During the interviewing and data collection process we soon realized that we cannot study the MAPS programme in isolation and expanded our analysis to knowledge creation on co-benefits in the IPCC. There may be other knowledge networks on co-benefits under different programmes.<sup>1</sup> These programmes appear on the margins of the network, as their participants were not interviewed – this does not mean that their work on co-benefits is insignificant, but merely that it is outside the focus of the South–South collaboration we chose to analyse. We interviewed two to three of the team members that did most of the work on co-benefits in MAPS in each country. In the IPCC, we interviewed five authors who worked on co-benefits in developing countries. We conducted 16 interviews in total. The following section shows the networks that emerged from the interview data.

## 5. Analysis: knowing how to integrate climate and development policies

The analysis of the knowledge network on climate and development policies consists of two parts. The first part focuses on the question of how knowledge creation works in a South–South collaboration. The answers to this question emerge from a SNA of the knowledge network on co-benefits. The second part explains which knowledge holder created what specific knowledge. This analysis reflects both the actors and their contributions to new knowledge and provides insights into the new knowledge that was generated on co-benefits in this South–South collaboration.

### 5.1. Social knowledge networks on co-benefits

Theory suggests that knowledge emerges from specific types of interaction between the knowledge holders. The main interactions we identified in the interviews were (i) short-term collaboration, which consisted of once-off meetings, workshops or email exchanges; (ii) longer-term co-working, which refers to consistent working relationships on specific projects or beyond; (iii) co-authoring, which is a specific collaboration with the purpose of producing a written output. These outputs are written for academic publication and passing through academic peer review processes. These relationships correspond to the types of interactions in the theoretical framework.

The types of interactions are characteristic of the different phases and spaces of knowledge creation. We can identify the network shown in [Figure 2](#), which shows the actors involved in the knowledge network on co-benefits. The nodes are the individual knowledge holders; white circles are affiliated to academic institutions, blue circles represent government affiliations, and yellow ones stand for business actors. The knowledge holders in the network are mostly affiliated to academic institutions. We also distinguish different types of interactions: short-term collaboration in yellow, co-working in blue, and co-authoring in green.

The network shows 10 central nodes, which can be grouped into seven working groups on climate change co-benefits – the Colombian, Chilean, Peruvian, Brazilian, South African and Indian research teams which worked on co-benefits under the MAPS Programme, as well as the group of authors that worked on co-benefits under the IPCC. Each group shows connections with other individuals. The main connections between the groups run through the individuals who were more central in coordinating work on co-benefits.

The interactions between the groups are quite different. Those between some of the South African researchers and the groups in Colombia, Chile and Peru are mostly characterized by short-term meetings and co-working relationships. The Indian, Brazilian and other South African

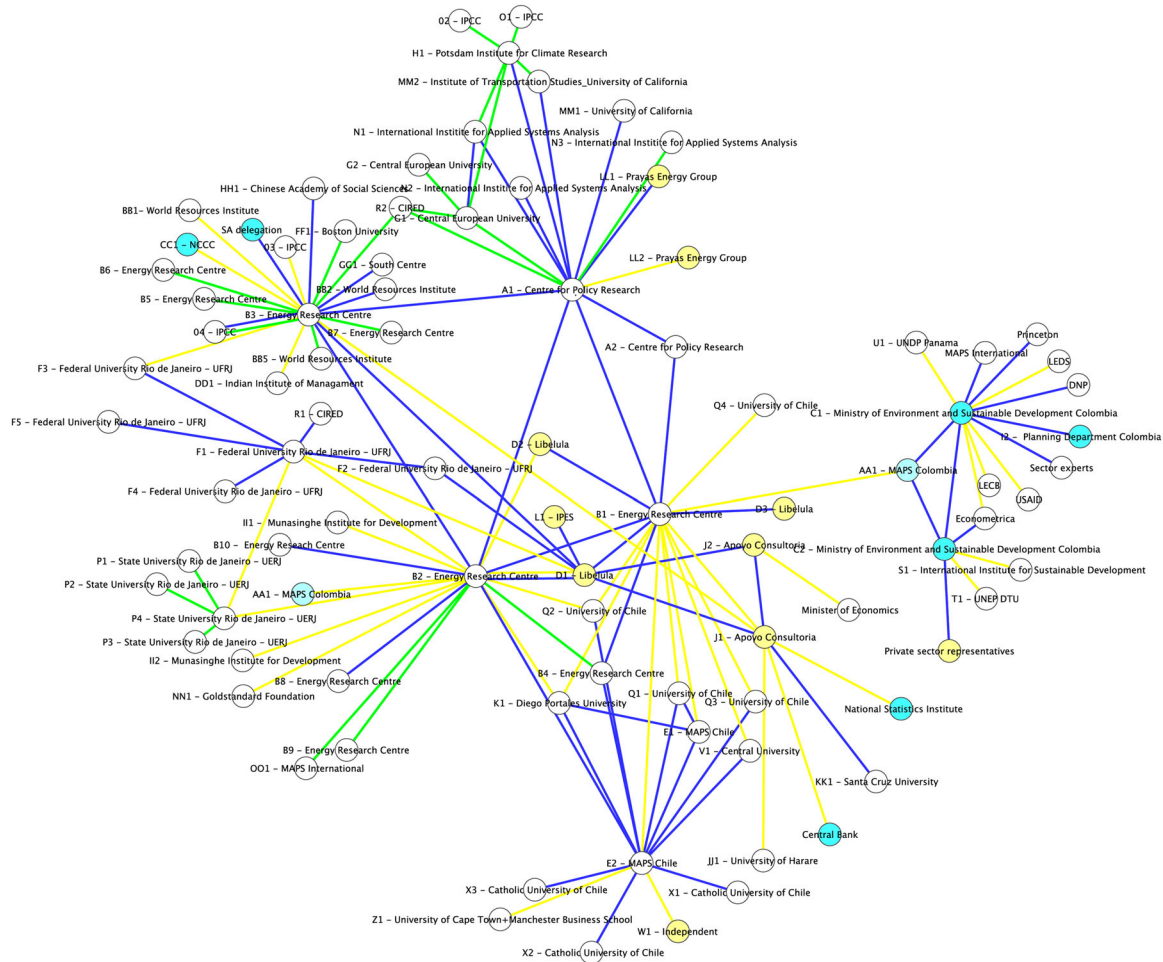


Figure 2. SNA of collaboration on co-benefits. Source: Own compilation based on interview data.

researchers have established some co-authoring relationships besides co-working and short-term interactions. Co-authoring is the dominant form of engagement of the group of the researchers involved in the work of the IPCC.

The different interactions indicate different phases and spaces for knowledge creation, as we saw in the analytical framework in Figure 1.

### 5.1.1. Socialization: originating space from tacit to tacit knowledge

“Learning by doing” stands at the very beginning of the process of problem-solving. The theme of co-benefits was a new concept to many practitioners in the scenario-building process under the MAPS programme.<sup>2</sup> The participative knowledge co-production processes aimed to identify mitigation action opportunities and their social and economic impact. Taking developmental priorities and policies into account was necessary and the problem of multiple objectives became evident very early on, though the solutions came late in the process.<sup>3</sup> The beginning of the

work on co-benefits involved talking to people, finding the appropriate team and information in the literature.<sup>4</sup>

Researchers assessed co-benefits or co-impacts of mitigation actions in their country contexts. The results differ from country to country. The main commonality in Colombia, Peru and Chile was that the groups approached co-benefits in a very applied way with the purpose of integrating them into national climate policy planning processes. Time and capacity constraints, mainly emerging from the desire to keep pace with national policy-making, did not allow for extensive research before starting these processes.<sup>5</sup> The results that came out of the processes are, however, relevant for the decision-making processes. They have not been converted into formal peer-reviewed research outputs yet, which explains why the majority of the results from the national co-benefits assessments has been in the space where new knowledge originates.

As a result, regular meetings, workshops and closer team collaborations characterize the knowledge production in the MAPS network. These types of collaboration favour the exchange of tacit knowledge needed to tackle an

immediate research problem in an applied policy setting. “Learning by doing” was especially integral to the approaches of the groups in Chile, Colombia and Peru,<sup>6</sup> where they tried out different methodologies and approaches to assess co-benefits in a meaningful way. As a result, three groups produced different results of mixed quantitative and qualitative methods. We will elaborate on the details of their knowledge contributions in Section 4.2. A workshop programme<sup>7</sup> supported the research in the network, which created important spaces for face-to-face collaboration throughout the network.

#### 5.1.2. *Externalization: dialogue space that creates explicit from tacit knowledge*

In the dialogue space, knowledge holders turn tacit knowledge into explicit knowledge. This process occurred in all nodes of the network to a different extent. It involves codifying the knowledge created in the originating space, but also research that was conducted on co-benefits outside the network. The knowledge created in the work of the Colombian, Chilean and Peruvian teams is still mainly tacit. A few reports have already emerged on co-benefits in the MAPS programme (Wlokas et al., 2013, 2014). The research groups in India and South Africa had more time to publish, as they did not apply co-benefits assessments in national scenario-building processes to the same extent. The Brazilian group built co-benefits as the research on socio-economic implications of mitigation actions into their modelling. Their work did not relate explicitly to the concepts of co-benefits. So far, the research has mainly been codified in the forms of Masters and PhD theses.

#### 5.1.3. *Combination: systematizing space of explicit knowledge*

The systematizing space refers to the process of combining different explicit knowledge resources. A literature review would be a classic example. The IPCC is the main platform to systematize explicit knowledge outputs, by definition, as the role of its assessment reports is to assess all peer-reviewed literature on climate change in a specific period.

The approach to addressing co-benefits has evolved throughout the IPCC’s five assessment reports. Working Group III – the mitigation component of the Fifth Assessment Report (AR5) – outlines the importance of broadening the conversation beyond a narrow co-benefits assessment of climate policy, and the need for mainstreaming climate objectives in sustainable development (SD) strategies. The broad interpretation of co-benefits is reflected in the definition of co-benefits in the IPCC’s AR5. The report includes a chapter on SD and equity, which provides an overview of how SD and equity need to be integral to all facets of mitigation policy. Co-benefits

and adverse effects are integrated in each of the AR5 sectoral chapters (IPCC, 2014).

The South African research group did some review work on co-benefits (Wlokas et al., 2013; Wlokas et al., 2014). Review papers and policy briefs on co-benefits aimed to support the work in Brazil, Colombia, Chile and Peru. Most of these outputs came out of the South African research group that had an explicit role to play in supporting the research in the Latin America groups.

#### 5.1.4. *Internalization: exercising space that converts explicit knowledge to tacit knowledge*

Exercising refers to the space that connects explicit and tacit knowledge. The IPCC authors did a lot of the internalization, because they are required to make sense of the existing literature. The face-to-face spaces and co-authoring in the process of the assessment report writing boosts the internalization of explicit to tacit knowledge and creates well-trained climate experts. “The IPCC is a major capacity-building mechanism” as one of the lead authors put it.<sup>8</sup> Lead authors referred to steep learning through the exchange with other authors and the rigorous review process of the chapters. The IPCC was referred to as an important space in which to advance and structure the concepts of co-benefits.<sup>9</sup>

The interviewees involved in the IPCC could refer to key contributions in the research literature more easily than other interviewees. The interviewees in the Chilean, Colombian and Peruvian teams that worked on concrete policy processes referred to the work of organizations on co-benefits, like UNEP, WRI, or the systematized knowledge under MAPS international and other research programmes rather than any specific literature or the IPCC. The interviewees referred to a literature search at the beginning of the co-benefits work in the scenario process, but it did not seem very useful for the problems that the teams were facing in the respective countries. The interviewees drew attention to the importance of locally generated information. This information was regarded as the most relevant and appropriate for co-benefits assessments in their country contexts, while the international literature on co-benefits was useful for providing guidance for methodologies.<sup>10</sup> Internalization in these groups occurred in the process of making sense of the literature and the policy problems and combining useful elements into new knowledge applied to the specific country’s needs.

The South African and Indian groups operated more in this exercising space. The Indian group produced publications through their involvement in the IPCC (Ürge-Vorsatz, Herrero, Dubash, & Lecocq, 2014) and the attempts to influence the domestic climate policy process (Dubash, Khosla, Rao, & Sharma, 2015; Dubash, Raghunandan, Sant, & Sreenivas, 2013). The South African group also shared connection to the IPCC, but offered

systematized explicit knowledge on co-benefits in the collaboration with the Latin American teams (e.g. Wlokas et al., 2013, 2014).<sup>11</sup> The explicit knowledge creation here required stocktaking of the research literature as a starting point. Figure 3 illustrates the main findings on the interaction in the Southern knowledge network on co-benefits. It shows the analytical framework populated with the findings of the SNA. While some teams acted in all spaces, others mostly concentrated on one or two phases, because of the nature of their work. The distinctions are not always clear-cut, but the framework certainly helps to understand how tacit and explicit knowledge creation occurs in different spaces.

**5.2. Knowledge networks: knowledge holders and their ideas**

The network produced new knowledge on climate and development in 17 areas. These areas refer to definitions and methodologies, as well as specific approaches to co-benefits analysis in six developing countries. Figure 4 illustrates the knowledge areas (in green circles) and the actors who were most associated with these topics (in white circles). The connections between the actors and knowledge contributions are undirected, which means that the actors could be associated with a specific topic. Actors share a connection, if they are associated with a specific knowledge contribution.

The structure of the network shows an almost equal distribution of actors with the knowledge creation that occurred in the processes of the six developing countries. The country-specific knowledge contributions were

particularly dominant in the actors associated with the MAPS network. These actors also predominantly focused on macro-economic modelling of co-benefits that shows a big cluster on the left side of the network.

Macro-economic modelling played a strong role in the national assessments of co-benefits in Brazil, Chile, Colombia and Peru. The scenario building processes link participative stakeholder processes to a modelling exercise which projects emissions and development trajectories into the future up to 2030 and 2050. The approaches to model emissions and socio-economic impacts within these processes derived from computer-generated equilibrium (CGE) modelling. The models established impacts on GDP, income distribution, employment and inequalities. Four research groups in Brazil, Chile, Colombia and Peru developed novel macro-economic equilibrium models, linked with sector-based bottom-up models, to assess impacts of policies for emissions reductions on socio-economic development.

The Peruvian research group clusters on the left side, with strong connections to macro-economic modelling. Initial qualitative and quantitative analyses of co-benefits of each mitigation action in Peru did not produce satisfying results. The team finally chose a matrix for scoring the relationship between each mitigation action and the co-benefits. Scores identified mitigation actions with the biggest negative and positive impacts. The two mitigation actions with the highest impact on cost savings and emissions reduction in each sector were then quantified to feed into a CGE model. The model produced analyses on the impact of scenarios on GDP, capital accumulation, public and private investment, salaries, exchange rate, the

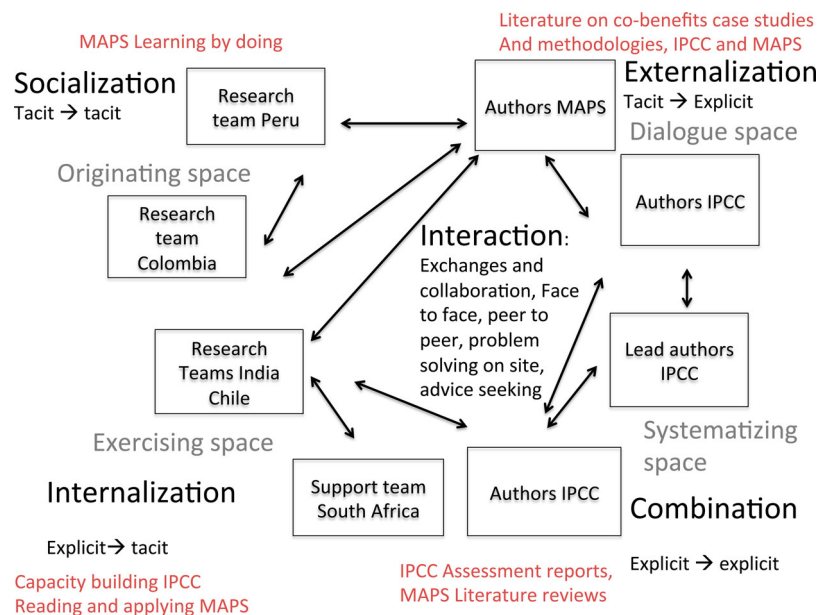


Figure 3. Processes and spaces for knowledge creation in MAPS and IPCC networks. Source: own compilation based on the theoretical framework.



of the social, environmental, health and institutional co-impacts of each of the mitigation measures. This assessment informed the process of scenario building. A Dynamic Stochastic General Equilibrium model calculated costs to the economy, emissions reductions and employment implications of all actions. The investigation into the co-impacts of mitigation policy included a qualitative analysis of selected interventions for emissions reduction measures and an assessment of socio-economic implications and conditions for implementation (Cohen et al., 2015; Wlokas et al., 2014). Eleven measures were prioritized according to specific criteria by the SBT and ratified by the project steering committee. The approach evolved to incorporate an analysis of implementability and the associated implications of implementing different scenarios. The main goal is to provide decision-makers with the ability to best implement mitigation measures.

The process involved 50 experts on 11 mitigation measures and their related impacts through three half-day meetings for five sectors. Experts identified key conditions, which would determine potential impacts. These conditions are one central result of the Chilean analysis. The timing of the process did not allow for major inputs on co-benefits into the Chilean INDC, although it is anticipated that the information on co-benefits will be key for decisions on its implementation.<sup>12</sup>

The Colombian, Chilean, South African and Indian researchers developed interest in applying MCDAs to the problem of co-benefits. MCDA has a central position in the network, because four countries contributed to advancing this methodology for co-benefits assessment. Co-benefits assessments try to solve priority setting with multiple policy objectives. MCDA turned out to be a useful methodology to “structure the problem”<sup>13</sup> of multiple, and possibly conflicting, objectives that climate and development policies may achieve. However, the stakeholder processes that aimed at verifying modelling results and prioritizing mitigation actions were unwieldy for both stakeholders and researchers. A group of international researchers, including researchers from South Africa, India and Chile, is currently advancing the research on

MCDA for co-benefits analysis, as demonstrated in Khosla, Dubash, Dukkupati, Sreenivas, and Cohen (2015), which investigates the role of MCDA in energy and climate policy.

The Indian and South African research groups cluster on the right side of the network, for two reasons. Firstly, both the South African and Indian contributions to MAPS were mostly research based. Both countries did not run participative scenario-building processes on climate and development. In South Africa, a long-term mitigation scenario planning process ran between 2005 and 2006, and this inspired the MAPS programme (Raubenheimer, 2011; Winkler, 2010), in which the South African research group had a support role. The Indian research team chose to inform the Indian policy processes principally through research and critical analysis of the modelling inputs from other research groups. Secondly, each group has a researcher who is involved in authorship in the IPCC. Both have contributed to the work on development and mitigation in the assessment reports and create critical connections to the IPCC knowledge network.

The Indian research on co-benefits currently focuses on advancing MCDA as a methodology for co-benefits assessment. The research group established a joint project with the South African group on this topic. The Indian team identified that currently available modelling approaches in India lack the ability to support multiple objectives decision-making, which is required to address climate and development (Dubash et al., 2015).

The South African research builds on a body of work on the problem of emissions reductions and poverty alleviation that goes back to the early 2000s. The concept of Sustainable Development Policies and Measures found its way into the IPCC assessment reports (Ellis, Baron, & Buchner, 2007; Winkler, Höhne, & Elzen, 2008; Winkler, Marquard, et al., 2008). The contributions on mitigation and development from Indian, South African and Brazilian researchers were well recognized by other IPCC authors.<sup>14</sup> The three authors in the Brazilian, Indian and South African research groups create the main link between the MAPS and the IPCC knowledge networks.

Table 1. Overview of key knowledge contributions in the IPCC and MAPS in the knowledge networks.

IPCC	MAPS
Development and mitigation	Multi-criteria decision analysis
Integrated assessment modelling	Macro-economic modelling of co-benefits
Definitions	Validation and quantification
Sectoral approaches to co-benefits	Strategic assessment of co-benefits
Validation and quantification	Sectoral approaches to co-benefits
Uncertainties	National co-benefits assessment informing public policy processes (Brazil, Chile, Colombia, India, Peru, South Africa)
SD-PAMs	Mitigation action impact matrix

Table 2. List of interviewees.

No.	Code	Affiliation
1	A1	Centre for Policy Research
2	B1	Energy Research Centre, University of Cape Town
3	C1	Ministry of Environment and Sustainable Development Colombia
4	C2	Ministry of Environment and Sustainable Development Colombia
5	D1	Libélula
6	E1	MAPS Chile
7	F1	Federal University Rio de Janeiro UFRJ
8	G1	Central European University
9	E2	MAPS Chile
10	B2	Energy Research Centre, University of Cape Town
11	B3	Energy Research Centre, University of Cape Town
12	H1	Potsdam Institute for Climate Research
13	I1	National Planning Department Colombia
14	J1	Apoyo Consultoria
15	J2	Apoyo Consultoria
16	P1	State University Rio de Janeiro UERJ

Table 1 summarizes the main knowledge contributions that emerged from the IPCC and the MAPS programme. There are overlaps on macro-economic modelling, quantification and sectoral approaches. MAPS stands out for the applied contributions on co-benefits assessments in national policy processes in developing countries. The IPCC advances general concerns on the relationship between climate mitigation and SD, definitions and concepts, integrated assessment models, uncertainties and, very importantly, sectoral approaches including health and air pollution (Bell et al., 2008; IPCC, 2014; McCollum et al., 2013; Nemet, Holloway, & Meier, 2010; Riahi et al., 2012; Smith et al., 2009).

## 6. Conclusions

The analysis of knowledge networks in co-benefits in climate change and development showed two networks. The first revealed the interactions between knowledge holders in MAPS and the IPCC in 10 clusters and seven research groups. The second showed 17 knowledge areas that emerged from the work in MAPS and the IPCC.

Both the interactions, as well as the knowledge created in MAPS and the IPCC, differ. The IPCC network deals mostly with academic knowledge creation and systematization. It helps to originate new knowledge, especially on definitions, concepts and methodology. Furthermore, the IPCC is a beneficial networking and dialogue space for new knowledge as well as a mechanism to boost tacit knowledge in a specific group of climate change experts. The MAPS network consists mainly of practitioners in government, academia, consultants and sector representatives who, through working together, attempt to apply the co-benefits assessments in real policy planning processes. In Colombia, Peru and Chile especially, this process has been continuously evolving

through a learning-by-doing approach, which has been predominantly based on tacit knowledge interactions. The actors in this originating space made little reference to the IPCC.

The limited connection between the two knowledge networks can in part be explained by the different approaches to co-benefits and timing. The IPCC has an academic approach to peer-reviewed research, stocktaking and synthesizing. The MAPS programme focused on national policy problems with the attempt to integrate development and climate policies in practice. These processes were grounded very much in the political realities of climate change and poverty in developing countries. The MAPS program has an applied approach. The immediate problems of linking climate and development policy inspired new knowledge. Time and capacity constraints have prevented this knowledge from being fully converted into explicit knowledge outputs up to now, although as the country processes have drawn closer to completion, the teams have focused more of their time on generating explicit knowledge outputs.

In sum, our analysis demonstrates that there is a substantial network of knowledge holders involved in creating knowledge about climate and development co-benefits. Yet, knowledge creation can benefit from actors in the knowledge networks becoming more closely connected to those who aim to apply new knowledge to increase integration of climate and development policies.

Strengthening the network connections between practitioners in developing countries and academics worldwide can benefit both communities. This requires a closer interaction between the externalization and internalization spaces, which are the main gaps we identified in our analysis. A foreseeable benefit of bridging this divide would be greater access to information on co-benefits assessments and methodologies for those conducting such processes

in the reality of the public policy processes in developing countries. Many of the interviewees in the MAPS countries indicated that experience with co-benefits assessments in their countries was limited. Drawing on international experiences was crucial. Consequently, they placed an emphasis on obtaining information, particularly on methodologies, from international experiences, of which they cited the information provided by MAPS International and the workshops as key sources of information. Interestingly, none highlighted the IPCC as a key source of information. The interviewees were either unfamiliar with the IPCC work on co-benefits or found the knowledge not applicable for the realities in the country processes. Time also constrained the extent to which the research groups were able to engage with the IPCC's evidence base. The research groups indicated that external sources of information had limited relevance for their specific contexts. They highlighted the importance of working closely with sector representatives and ministries in their countries, as these had the most in-depth knowledge of the sectors and their objectives. The co-benefits assessments had to align these objectives (Table 2).

The more academic networks in the IPCC can benefit from increased interaction with those involved in applied processes and vice versa. These connections establish more proximity to the challenges of conducting co-benefits assessments in the reality of policy planning processes, and competing with numerous other policy priorities. In some instances this proximity has been established through lead authors in developing countries, but the proportions continue to favour a stronger representation from industrialized countries. Bridging the existing gap between the networks can strengthen their knowledge outputs and contribute to better-informed public policy processes.

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### Notes

1. Interviewees mentioned the United Nations Environment Programme (UNEP)-funded projects, Latin American Modelling Project, and World Resources Institute (WRI).
2. Interviews 5, 3, 6, 7, and 9.
3. Interview 6.
4. Interviews 3, 4, 5, 6, and 9.
5. Interviews 5 and 6.
6. Interviews 5, 6, and 14.
7. A workshop programme (put together by the South African team) supported the collaboration between the research

groups on especially pressing research areas, including co-benefits, economic modelling, leadership and multi-criteria decision analysis.

8. Interview 11.
9. Interviews 8, 11, and 12.
10. Interviews 3, 4, and 5.
11. Further materials are several presentations and training sessions that took place during two workshops on co-benefits in Bogotá and Cape Town in 2013 and 2015.
12. Interviews 6 and 9.
13. Interview 1.
14. Interviews 8 and 12

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