THE WATER-ENERGY-FOOD NEXUS IN LATIN AMERICA AND THE CARIBBEAN

Trade-offs, Strategic Priorities and Entry Points

About the Global Canopy Programme

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EXECUTIVE SUMMARY

1. TOWARDS A NEXUS APPROACH

In our hyper-connected world, water, energy and food are increasingly interdependent. In Latin America and the Caribbean (LAC), water is at the heart of this nexus and underpins hydropower generation, agricultural production and industry. In a continent under increasing pressure from climate change, and national and international demand from growing populations, understanding and accounting for these interdependencies is vital for achieving longer term economic, environmental and social goals.

As a region, LAC is abundant in water, energy and land resources and these have been harnessed to fuel economic growth across the region. Whilst this has supported progress in social wellbeing, high levels of inequality persist and millions of people still remain without water, food and energy security. Furthermore, the intensive development of agriculture, mineral and energy endowments has gone hand in hand with large-scale pollution and deforestation, undermining ecosystem services and threatening water security that is of vital importance for the region's economies and citizens. Climate change is now further multiplying these threats through changing rainfall patterns and extreme weather events.

Recent water crises in the region, including the severe 2014 drought in Brazil's economic heartland in the south-east of the country, have brought trade-offs between water, energy and food to the fore. Even in areas of great overall water abundance, such as Amazonia, severe droughts have highlighted a once unthinkable vulnerability.

But water scarcity is nothing new for many of the growing urban and industrial centres that are not well served by the continent's unevenly distributed water resources. The Peruvian Amazon basin, for example, contains 97.5% of the country's surface water but only 30% of the population, with urban centres and economic activity concentrated on the coast. In Mexico, more than 75% of economic activity, population and irrigated land is found in the central and northern region above 1000m in altitude, while 72% of water availability is lower down in the South[1].

For Latin America and the Caribbean to meet its ambitious economic, environmental and social targets, such as those set out under the forthcoming Sustainable Development Goals and UNFCCC climate agreement, nexus thinking will be a prerequisite for success. Not as an emergency response to solve crises as they occur, but as an established approach to address challenges and opportunities in a hyper-connected landscape: to identify and resolve trade-offs, foster synergies, and optimise outcomes across different actors and sectors.

2. KEY TRADE-OFFS:

Water and Energy

• **Hydropower** is the source of around 65% of electricity in LAC. Many countries have plans to exploit their remaining hydropower potential. However, hydropower is vulnerable to climate change and countries will need to diversify their energy matrix to protect energy security. Hydropower infrastructure development can also lead to conflict over access to water and other social and environmental impacts.

• Water and energy systems are tightly connected, for example in agricultural irrigation, domestic and industrial supply, water treatment, energy generation through hydropower, and cooling in thermal power stations. Improving the efficiency of **coupled water-energy** systems through better management, investing in infrastructure, and reforming subsidies would benefit water, energy and food security.

Energy and Food

• Increased **biofuel production** could compete with food crops for water and land. Investing in agricultural waste as a source of biofuels, agro-ecological land-use zoning, and prioritising biofuels that thrive on marginal agricultural lands could help to mitigate this potential trade-off.

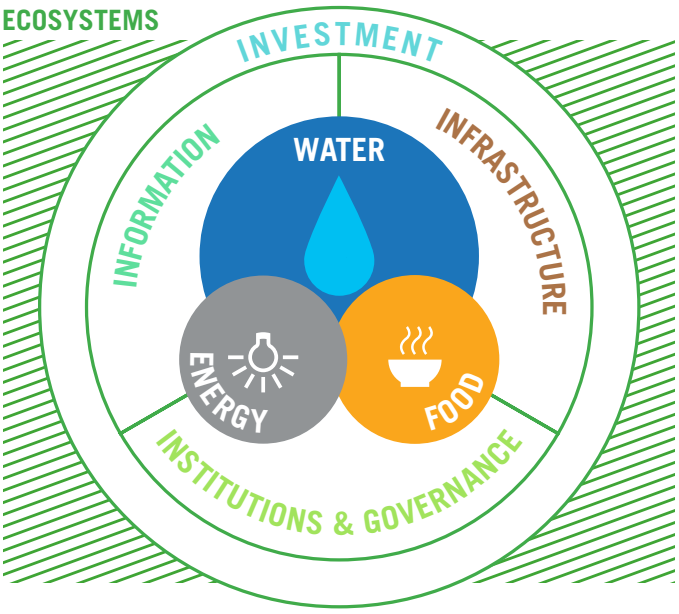
Food and Water

• **Agriculture** accounts for over 70% of water use in the region. Primarily rain-fed, agriculture relies on **irrigation** in semi-arid zones. Agricultural exports support global food security and Latin America is expected to play a key role in meeting growing international demand for food. However, agriculture is the largest **driver of deforestation** in LAC, threatening the region's water security.

• In order to adapt to climate change and growing demand for water from other users, the agricultural sector is under pressure to produce more whilst reducing its water, carbon and deforestation footprint.

A Framework for Action

Our analysis of how to minimise the impacts of these trade-offs and build resilience is based upon a simple framework comprised of the 4 interlinked elements needed to enable a nexus approach: infrastructure, information, institutions and governance, and investment. More detail can be found in section 6, but the key trade-offs, strategic priorities, and entry points for action that emerge from it are summarised below.



3. STRATEGIC PRIORITIES:

1. Coherent landscape planning

Coherent planning across water, energy, food, ecosystems and climate change is essential to achieve inherently cross-cutting goals in each sector. Whilst mechanisms exist to promote policy integration, effective coordination and implementation are limited by governance gaps. With the region's countries planning to expand hydropower infrastructure and output, for instance, optimising outcomes at the system scale rather than the project scale will be increasingly important. Criteria for prioritising hydropower developments at the basin scale could include river connectivity, indigenous territories, mining concessions, productive agricultural land, and deforestation and climate change scenarios.

2. Strengthen water governance

Weak water governance is a key barrier to horizontal and vertical coordination across water, energy and food sectors. Water policymaking is highly fragmented within central governments and often decentralised with little vertical coordination. Weak management by utility companies, poor quality infrastructure, and low water pricing are all challenges to water-use efficiency that can be addressed by improving governance.

3. Improve monitoring systems

Water pollution from poor waste management and treatment, agricultural inputs such as nitrates, and the extractives industry is a major threat to the region's water security. Information on water quality is patchy, and better monitoring systems are needed to identify issues and analyse interventions. Monitoring systems can also support efficient resource use and allocation in watersheds, industries and households.

4. Quantify trade-offs

Accessible decision support tools that can help stakeholders to build future scenarios, identify policy responses, and quantify the resulting economic, environmental and social trade-offs are needed to help decision-makers identify 'quick wins' and 'low regret' options for optimising water, energy and food security. Analytical tools such as Water Evaluation and Planning (WEAP) and Caribbean climate change risk and adaptation (CCORAL) are already being used by decision-makers in the region. However, there is a need for tools that encompass the whole water-energy-food nexus to ensure fully integrated outcomes.

5. Decouple agriculture from deforestation

Agriculture is the largest driver of deforestation in the region. To transition from business-as-usual to deforestation-free agricultural supply chains, investment is required in integrated approaches such as agro-ecological zoning, sustainable intensification and restoration of degraded lands (recognising trade-offs with water and energy), and human and technical capacity for green commodity production. A landmark set of commitments by companies across the globe to transition to zero-deforestation supply chains by 2020 offers a further opportunity to create demand for green commodity production in Latin America. Ultimately, prioritising and investing in diversifying economies beyond the exploitation of primary resources offers a longer-term vision for climate-compatible development.

6. Adjust price signals

The historic subsidisation and low pricing of water has promoted inefficiency and does not reflect the true cost of its use or of negative externalities to the environment, such as pollution. This is also true for agriculture, energy and mineral production, where negative environmental externalities such as deforestation, pollution and degradation are not internalised in the cost of goods produced. Payment for Ecosystem Services (PES) programmes in the region represent a step towards recognising the value of ecosystems and the costs of environmental externalities; but a systemic shift is required to internalise all externalities in the costs of resource use. At the same time, social tariffs and programmes need to be put in place to ensure that higher costs do not undermine water, food and energy security for the poorest.

4. ENTRY POINTS:

1. International commitments

Ambitious multi-lateral agreements on the environment and development are inherently cross-cutting; therefore an integrated approach will be essential to achieve their economic, environmental and social goals. In particular, forthcoming agreements on the Sustainable Development Goals and climate change mitigation and adaption under the UNFCCC directly impact and rely on water, energy and food security.

2. Climate change adaptation

Adapting to climate change will be essential for building resilience and managing risks to water, energy and food security from changing rainfall patterns, more frequent and intense extreme events, and rising temperatures. Whilst the region's countries have different levels of exposure, vulnerability and capacity to adapt to climate change, urban slums, hydropower generation and food production are particularly at risk. Historically, climate change policies in the region have been poorly coordinated with other sectoral and macroeconomic policies. Integrating national and local climate change adaptation plans within and across sectors offers an urgent entry point to avoid maladaptation and negative externalities.

3. New infrastructure projects

The opportunity must not be missed to apply nexus approaches to the extensive new infrastructure development that is already planned in LAC, and that will influence water, energy and food security outcomes for decades to come. For instance, by prioritising multi-purpose dams, benefits can be delivered to a wider spectrum of water users. Infrastructure designs should also examine the role of natural infrastructure, which can bring important co-benefits, in complementing or replacing built infrastructure solutions.

4. Cities

There has been rapid urbanisation in the region over the last 50 years. Now 80% of the population lives in urban areas, one of the highest rates globally. Cities have developed around sites originally chosen to suit the very different needs and contexts of colonial expansion. As a result, some of the region's largest cities are now facing water scarcity issues. Many of these cities, including Rio de Janeiro, Sao Paulo, Mexico City, Lima and Caracas[2], are transferring water from neighbouring basins. Nearly a quarter of residents are estimated to be in urban slums with low access to affordable potable water, energy and food. Key challenges include weak and fragmented governance, poor management of utilities and pricing, and low infrastructure quality. Integrated solutions such as using treated waste water for urban agriculture can help maximise resource-use efficiency.

5. Integrated water resource management

IWRM is an established concept in the LAC region and thus offers an entry point for integrated nexus thinking. However, water governance gaps, including fragmented policymaking, capacity issues, funding, and monitoring and evaluation remain challenges for its successful implementation. Strengthening IWRM through a nexus approach calls for engaging with actors beyond the watershed scale, for example with energy policymakers in the national government and companies in agricultural commodity supply chains.

6. Corporate commitments and stewardship

Companies throughout the complex supply chains that connect LAC's natural-resources to regional and global markets have a key role in determining sustainable resource-use and demand. Globally, companies have made ambitious pledges to transition to 'zero deforestation' or 'zero net deforestation' supply chains by 2020; this includes a commitment by the Consumer Goods Forum, a global alliance of 400 companies with combined sales of USD 3 trillion annually. Furthermore, a number of companies from the region are engaged in disclosure and accounting projects on water, forests and carbon. This offers an opportunity for governments and civil society to support and incentivise good corporate stewardship.

7. Payment for Ecosystem Services

Latin America is a global leader in the development of PES programmes, for example Socio Bosque in Ecuador and Mexico's Payment for Watershed Services. Water funds have also flourished in the region, including for several major cities such as Bogota, Lima and Quito. The Latin America Water Funds Partnership, capitalised by USD 27 million, aims to support 32 water funds that conserve 7 million acres of watersheds and secure drinking water for 50 million people. There is an opportunity to build on existing lessons and expertise in the region to incentivise actors to secure the provision of vital watershed services for energy generation, agriculture, industry and domestic supply.

Section 1: Introduction

1.1 GOAL AND SCOPE OF REPORT

This report provides an overview of the water-energy-food nexus in Latin America and the Caribbean (LAC), identifying the main challenges and opportunities for achieving water, energy and food security in the region. There is a particular focus on the Latin American countries Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, and Peru. This report builds on IUCN and IWA's Latin American Nexus Dialogue workshop in 2013 and the Amazonia Security Agenda project (www.segamazonia.org) and is informed by 41 interviews with key stakeholders across water, energy and food sectors in the region (Annex 1).

The goals of the report are to support public and private sector decision-makers in the region by identifying:

1. Key trade-offs between water, energy and food;
2. Strategic priorities to address key challenges for water, energy and food security;
3. Entry points for a regional nexus dialogue.

1.2 WHAT IS THE NEXUS?

The water-energy-food (WEF) nexus is a new model for action informed by the interconnections between different sectors. It builds on a long history of integrated management approaches. The main premise of the nexus approach is that in our hyper-connected world water, energy and food are increasingly interdependent, with impacts in one sector affecting the others. In a planet under pressure from climate change and growing demand from larger and increasingly affluent populations, understanding and accounting for these interdependencies is vital for achieving longer term economic, environmental and social goals.

Whilst the value of a nexus approach has been demonstrated in identifying complex synergies and trade-offs, less focus has been given to the development of practical nexus tools and frameworks to support proactive and integrated decision-making.

Water underpins both energy and food security. Water is also vulnerable to climate change and environmental degradation. Water is therefore often the first entry point for applying a nexus approach.

NEXUS TRANSLATED

When introducing the 'nexus' or 'nexus approach', it is essential to use case studies and examples to illustrate the concept as these are not widely-understood terms and are defined in varying ways by different organisations. This issue becomes further complicated when dealing with translation, as not all languages have an exact equivalent. For instance, in Spanish and Portuguese the direct translation 'nexo' is not a commonly used word in either language, which created difficulties when trying to communicate this concept in the interviews conducted for this report. Instead, 'vinculo' was used as a more effective alternative in both languages, however further explanation was still needed to communicate the idea of trade-offs and synergies between water, energy and food.

Water and Energy

Water is required for energy generation, including hydroelectric power, thermal power station cooling, extraction of petroleum, gas, uranium, biofuels etc., and biofuel crop production. Energy is also required for pumping water, for example for domestic supply and agricultural irrigation systems, water treatment plants, and desalination.

Energy and Food

Energy is required for all stages of the agricultural supply chain, including irrigation, agricultural mechanisation, processing, storage and transport. Growing biofuel crop production may compete with food crops for land and water. Agricultural and livestock waste can be used for biogas and biofuel.

Food and Water

Water is essential for agricultural production (rain-fed and irrigated crops), livestock and fisheries. Agriculture is the main user of water globally, and can impact water quality through pesticide run-off. Agricultural expansion is the biggest driver of deforestation, eroding water provisioning and water regulating ecosystem services, and undermining long-term water security.

1.3 THE NEXUS IN PRACTICE

In many cases, nexus trade-offs only emerge when one element of the nexus is impacted or at risk; for example, during floods and droughts when water security is dramatically affected, or in the development of large infrastructure projects such as dams, reservoirs or roads, which affect resource access for different users. These events often provide an entry point for discussions between different stakeholders around the resulting trade-offs, bringing together decision-makers from siloed sectors who would not normally interact.

A key challenge is ensuring that nexus approaches are not only reactive responses to emergency situations, but are embedded in longer-term planning processes and proactively applied to build resilience before critical situations arise.

National climate change mitigation and adaptation planning offers an excellent opportunity to integrate proactive nexus approaches into longer-term decision-making. In building resilience for water, energy and food systems, the nexus approach is inherently linked to climate change adaptation. This is reflected in the development of Huila Department's 2050 Climate Adaptation Plan in Colombia (page 17).

Case Study: Water conflicts in Brazil

A major drought hit the south-east of Brazil in 2014, affecting over 4 million people, industries and agriculture in the economic heartlands of Sao Paulo, Rio de Janeiro and Minas Gerais States. The drought led to severe water shortages, with Sao Paulo's Cantareira reservoir system falling to below 5% of its capacity.

Efforts by Sao Paulo to secure its water supply have put Brazil's three largest states in competition over access to their shared Rio Jaguari river basin. This is forcing trade-offs between different water uses including hydroelectric power generation, waste water treatment and urban supply. With the disputes threatening to reach Brazil's Supreme Court, the National Water Agency has stepped in and mediated an agreement between the three states to preserve water supply and energy production. January rains have brought some relief, but with only a third of the predicted volume of rainfall, they will not be enough to restore water levels in 2015.

Whilst poor planning and local environmental degradation have exacerbated the problem, the drought has been linked to the failure of the 'flying rivers' that transport moisture thousands of kilometres from the Amazon Basin. Critically, this could signal a longer-term threat to Brazil's water security, as hydrological systems are threatened by large-scale deforestation in the Amazon[3].

This so-called 'water war' has highlighted major deficiencies in water governance and infrastructure. Even in Brazil's richest state, the human right to water cannot be guaranteed. For the first time, this conflict has brought a climate change issue to the national consciousness in the form of a water and energy crisis.

In response, more than 40 civil society organisations have formed an Alliance for Water that aims to propose solutions, monitor the government's response to the crisis, and use this opportunity to catalyse a paradigm shift in the state's water management for a more secure future.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Section 2: Regional Context

Viewed as an entire region, LAC is abundant in water, land and energy; for example, the region has the greatest available water volume per capita globally, at approximately 25,000 m^3 per year[4]. However, there is spatial and temporal heterogeneity in the availability of resources between and within countries. For example, the Caribbean is less resource-rich than Latin America. The Caribbean islands have much higher water stress indices[1] than South and Central America, with Antigua and Barbuda, Barbados, Dominica, Jamaica, Saint Lucia, Saint Vincent and The Grenadines, and Trinidad and Tobago recording the maximum score[5]. In terms of temporal variability, the El Niño Southern Oscillation (ENSO), associated with periodic changes in sea surface temperature in the Pacific Ocean, has important impacts on resource availability, including changing rainfall patterns along the west coast of South America and nutrient availability for offshore fisheries. Critically, there are also asymmetries between resource demand and supply; for example, Peru's Amazon region has 97.5% of the country's surface water despite being home to less than a third of the region's population[6]. Conversely, both Northern Chile and Northern Mexico, whilst abundant in mineral and energy resources, are constrained by limited water availability.

Natural resource-based growth

The region's abundance of natural resources, including water, arable land, energy endowments and minerals has provided the platform for its economic development. Raw materials comprise more than half of LAC trade. Excluding Mexico, which has a strong manufacturing sector, nearly three quarters of exports are natural resource-based commodities such as petroleum, minerals and ores, oilseeds and livestock. The economic importance of Latin America's natural resources is underlined by the dominance of agriculture and mining in the top three exporting sectors of the region's largest 11 economies. Only Mexico and Argentina have a sector not directly based on natural resources in their top three[7,8]. Agricultural exports from Latin America, including oilseeds, livestock products and cereals, also play a key role in supporting global food security[9]. This is likely to continue due to the region's potential to expand production to meet growing global demand. One report suggests that of the remaining 445.6 million hectares potentially suitable for the sustainable expansion of cultivated land worldwide, about 28% is found in LAC[10]. Whilst infrastructure and logistics are currently a barrier to expanding agricultural exports, planned investments in transport and communications, such as through the Initiative for the Integration of the Regional Infrastructure in South America (IIRSA), will enable agricultural exports to increase.

Environmental degradation

The exploitation of natural resources has fuelled economic growth, but in many cases has had negative impacts on environmental health and social wellbeing, particularly for local communities. Large-scale commercial agricultural expansion is the dominant driver of deforestation in Latin America, causing around 70% of forest loss and impacting ecosystem services and biodiversity[11]. Agriculture is also the source of some 17% of greenhouse gas emissions in LAC. In 2010, agricultural emissions rose to more than 900 million tonnes CO2eq (from 388 million tonnes CO2eq in 1961) and are projected to continue to rise. Emissions associated with livestock were responsible for 88% of these emissions in 2010[12]. Although net forest conversion in LAC (mainly driven by agriculture) is declining, it is responsible for the majority of the region's emissions at around 1900 million tonnes CO2eq in 2010. In 2014, agriculture in Brazil was directly responsible for 26.6% of emissions and also a main factor in a further 34.6% of emissions from land use change[13]. Agriculture, energy and mining developments are also associated with pollution, particularly from mercury in informal gold mining.

Social wellbeing

Economic development has led to major reductions in extreme poverty across the region in recent decades. The proportion of the population living in extreme poverty declined to 11.7% in 2013, from 19.3% in 2002. However, 69 million people still live in extreme poverty in the region[14]. Income inequality has also

1. WRI Aqueduct Water Stress Index of Baseline Water Stress is the Ratio of Total Annual Water Withdrawals to Total Available Annual Renewable Supply.

declined, but is still significant, and higher than in all OECD countries outside of the region[15]. More broadly, progress towards achieving the Millennium Development Goals (MDGs) indicates significant improvements in non-income measures of social wellbeing[16]. However, there are large variations within countries – for instance, progress towards the MDGs in the Amazon Region is lower than national and regional averages, with child malnutrition found in 4% of the under-five population in LAC, but over 20% in the Peruvian and Bolivian Amazon[17].

Urbanisation

A further challenge to achieving water, energy and food security in the region is population growth and urbanisation. The region has the most urbanised population globally, with 80% living in cities. This is predicted to rise to 90% by 2050[18]. This rapid urbanisation brings challenges in urban planning. Despite improvements in the use of sanitation facilities and clean water, many citizens lack access to basic services (Table 1).

Climate change

Adapting to and mitigating climate change will be a defining challenge over the next few decades. Increasing temperatures, changing rainfall patterns, and more frequent and intense extreme weather events, including droughts and floods, are projected across the region. The resulting changes to water availability will impact agriculture, energy, industry and domestic use. Recent extreme droughts and floods in the region offer some insight into the likely challenges ahead. For example, in 2011 floods in Colombia associated with La Niña affected nearly 10% of the population and cost nearly USD 8 billion in losses from agriculture, infrastructure damage, and payment of government subsidies[20]. Central America is very vulnerable to climate change and particularly tropical cyclones; in El Salvador alone, losses from tropical storms totalled 6% of GDP between 2009 and 2011[21].

In this context, a nexus approach will be increasingly vital to enable decision-makers to proactively identify and resolve trade-offs and optimise outcomes for different sectors and actors.

Table 1: Improved use of sanitation facilities and use of drinking water sources[19]

	Improved use of sanitation facilities in 2010 (% population)				Improved use of drinking water sources in 2010 (% population)			
Country	Urban	Rural	National	% of population gained access since 1995	Urban	Rural	National	% of population gained access since 1995
Bolivia	67	10	27	11	96	71	88	31
Brazil	85	44	79	21	100	85	98	22
Chile	98	83	96	23	99	75	96	19
Colombia	82	63	77	22	99	72	92	22
Ecuador	96	84	92	32	96	89	94	31
Mexico	87	79	85	28	97	91	96	24
Peru	81	37	71	23	91	65	85	21

Case Study: Conflicts between water users in the Rio Santa watershed, Peru

The Rio Santa watershed in the Ancash region of Northwest Peru supports a wide variety of economic activities, including hydropower generation, mining, agriculture, and urban populations, supporting 1.8 million people.

Water security risks stem from downstream pollution caused by mining, municipal sewage and agricultural run-off, as well as water supply, which is regulated by a number of dams and reservoirs. Trade-offs are necessary between different jurisdictions, water users, and downstream and upstream actors. The watershed is fed by glaciers, so these pressures are likely to increase due to climate change, with more challenging dry seasons and declining flows projected in the long term. Conflict between different water users is already occurring: in 2008, farmers angered by their lack of access to a reliable water supply blockaded an upstream dam, which regulates water flow for electricity production at the Huallanca hydroelectric plant. This conflict was ultimately resolved through new water sharing agreements that require all stakeholders to approve changes to flows from the upstream lake.

The perceived prioritisation of coastal irrigation projects over smaller upstream agricultural users has also led to tensions. In 2011, Peru's National Water Authority (ANA) extended water reserves for a further two years to the Chavimochic and Chinecas coastal irrigation and water transfer projects to protect agricultural exports and electricity production; this led to protests from upstream water users who have no such supply guarantee.

As pressure on water resources increases due to climate change, it will be increasingly difficult to meet the needs of all water users. Resulting conflicts are unlikely to be resolved without the development of participatory water sharing agreements between all users. A nexus approach can help to proactively and equitably prioritise different uses and develop appropriate policy frameworks for future climate scenarios.


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Section 3: Trade-offs and Priorities

3.1 WATER AND FOOD

Latin America's abundance of arable land and water supports vast agricultural production. Agriculture is the largest user of water in the region, primarily through rainfall (green water): only 13% of arable land and permanent crops is irrigated[22]. This dependence on rain-fed agriculture, while less water and energy intensive than irrigated systems, has trade-offs in terms of lower productivity and greater vulnerability to drought.

Food Security

Latin America's agricultural production plays an important role in supporting global food security through the export of agricultural commodities, and will have a vital role to play in meeting future global demand. The region is not only exporting food, but also 'virtual water' embedded in agricultural commodities. In 2007, South America was estimated to virtually export 178 km^3 a year to Asia and Europe, around 17% of the water used for foo d production in the region[23].

Despite this large-scale production and export of agricultural commodities, an estimated 37 million people in Latin America and the Caribbean (6.1% of the population) suffer from hunger. This is a particular challenge in Haiti, Bolivia, and Nicaragua, where a high proportion of the population are undernourished (50%, 19.5% and 16.8% respectively). Chronic undernourishment is also higher among indigenous peoples and is double that of non-indigenous communities in Bolivia, Guatemala and Peru. However, LAC is the only region globally to have achieved the Millennium Development Goal target to halve the proportion of people who suffer from hunger between 1990 and 2015[24].

Deforestation

The expansion of agricultural land has gone hand in hand with deforestation – in Latin America around 70% of deforestation is driven by commercial agriculture, mainly oilseed crop cultivation and cattle ranching[25]. The resulting loss of ecosystem services, including rainfall recycling, water regulation and purification, moderation of extreme events, and climate regulation has local and regional impacts on water security. Amazonia recycles and exports moisture through 'flying rivers' thousands of kilometres from the Atlantic Ocean to the South of the continent, including to the economic heartlands of the La Plata Basin, which generates 70% of the GDP of the 5 countries that share the basin[26, 27]. Agriculture and associated land-use change are also major contributors to the region's greenhouse gas emissions.

In meeting future demand for food, it is crucial to decouple agricultural growth from deforestation. Options for achieving this include the intensification of agricultural production, recovery of degraded lands, reduction in food waste, expansion of irrigated land area and improvements in irrigation efficiency.

Pollution

The intensive use of pesticides and fertilisers to improve agricultural yields impacts water quality through run-off. One study estimated that the agricultural grey water from nitrate pollution corresponds to 46% of the total grey water footprint[28] (an indicator of water pollution) in the region. Brazil, Mexico, Argentina, Chile, Colombia and Peru were identified as the main contributors to the region's agricultural grey water footprint. Poor compliance with water quality legislation and monitoring systems are barriers to addressing pollution.

Irrigation

Currently 24.6 million ha of arable land are equipped for irrigation across the region[29]. The countries with the largest areas of irrigated land are Mexico with 6.4 million ha, Brazil with 5.4 million ha, Peru with 2.6 million ha and Argentina with 2.4 million ha[30]. Many countries have plans to expand irrigated land. For example, in Brazil the National Water Agency (ANA) has identified 29.6 million ha of potentially irrigable land nationally, of which less than 20% is currently irrigated[31].

Irrigation efficiency is poor, with an average of 39% across the region, which is lower than the global average of 56%. This low efficiency can result in salinisation, which affects 30% of Peru's coastal areas[32]. Higher efficiencies are seen in Chile and Brazil where investment has been made in more efficient irrigation systems, such as drip and sprinkler systems, which now cover

30% and 41% of irrigated land respectively[33]. However, more water-efficient irrigation systems are more energy intensive. Furthermore, in Mexico there is evidence that the shift to water-efficient systems has negatively impacted aquafer resources through increasing consumptive use and reducing return flows of water through evaporation[34].

Agriculture currently accounts for 72% of water use in the LAC region, but increasing demand for water from other users including domestic supply (currently 17% of water withdrawals), and industry (currently 11%) will put more pressure on agricultural producers to produce more with less[35].

TRADE-OFFS ACROSS SCALES, ACTORS AND SECTORS.

In identifying trade-offs and priorities in the water-energy-food nexus, it is important to recognise that these are different across actors, sectors and scales. For example, whilst hydropower supports national energy security and the mining industry, it is associated with local trade-offs between water and food security, which often affect marginalised communities.

In reality, such trade-offs are often mediated by existing power dynamics - including access to information, influence and voice, and technical capacity. For example, in Brazil the powerful rural-agricultural sector played a significant role in successfully lobbying for a change to the Forest Code in 2012 that weakened forest protection requirements for land-owners. A significant argument in their case was the need for land to safeguard food security, but without accounting for the role of forests in supporting regional water security and therefore food production.

Even when an integrated policy is in place, its effective implementation and outcomes across different sectors and actors are dependent on who is responsible for integration and how this integration process is governed[42].

Dialogue among all stakeholders is needed to prioritise more equitable approaches that are favourable for the widest range of resource users. This requires transparent information and the meaningful participation of marginalised actors such as indigenous communities. Whilst progress has been made, for example the rising participation of water-users in water policymaking through representation in River Basin Organisations, accountability was identified as a key gap in a regional study on water governance[43]. To achieve more equitable outcomes and enable real participation, building capacity amongst marginalised users to understand potential trade-offs is essential to empower them in negotiations.

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3.2 FOOD AND ENERGY

Biofuels

The biofuels industry is rapidly expanding, driven by national renewable energy targets and policy mandates for blended fuels both within the region and for export markets, including the EU, US and China. The LAC region now produces 27% of global biofuels; production doubled between 2001 and 2011[40]. Brazil is a global leader in the development of bioethanol and biodiesel, mainly from sugarcane and soybeans respectively, which is used as fuel in the motor industry. In 2013, Brazil produced 27.7 billion litres of bioethanol, the second largest volume globally behind the US[41]. Whilst Brazil and Argentina dominate production in the region, other countries have invested in biofuel production including Colombia, Costa Rica, Ecuador, Guatemala, Mexico and Peru. Furthermore, many countries have mandates for blended bioethanol and/or biodiesel in fuel including Argentina, Brazil, Colombia, Costa Rica, Ecuador, Jamaica, Panama, Paraguay, Peru, and Uruguay.

Further development of biofuels in the region could lead to competition for land and water resources between food crops and biofuels, with implications for land-use change, water, energy, and food security. Options to mitigate the potential impacts of biofuels on food security include developing biofuels from agricultural waste or focussing on biofuel crops that can be grown on marginal agricultural land such as Jatropha. Livestock waste can also be used for biogas as an alternative energy source.

Food supply system

Energy is required for the entire food system including food production, harvesting, transport, processing, packaging, and marketing. This has received limited attention in the water-energy-food nexus discourse so far, but is an important factor that needs to be considered.

3.3 ENERGY AND WATER

Hydropower and energy generation

Water is essential for energy generation in Latin America. Hydropower provides around 65% of electricity generation and around 11% of total energy generation in the region[36,37]. Only a quarter of the region's hydropower potential has been exploited (see table 1 in Annex 2). In particular, the Amazon Basin is an area with large untapped hydropower potential, which its countries plan to further develop. The Brazilian Amazon has nearly two thirds of the country's remaining hydropower potential; 30 dams are planned in the region by 2020, including the almost-completed Jirau and Santo Antônio dams on the Madeira River[38, 39].

However, hydropower is vulnerable to low water flows in the dry season. This is likely to be exacerbated by the impacts of climate change on rainfall patterns and the frequency and intensity of droughts. Social and environmental concerns and conflicts around hydropower development have also led to the preferential development of run-of-river dams in Brazil over the last decade, which have a smaller footprint but are more vulnerable to drought than reservoir dams. This vulnerability will require countries in Latin America to diversify their electricity matrix whilst reducing emissions from the sector as they transition to low-carbon economies.

Other energy sources also require water, including cooling in thermal power generation, nuclear power (currently in Argentina, Brazil and Mexico), biofuel production, and the extraction of fossil fuels. Furthermore, both hydropower generation and fossil fuel extraction have impacts on local water and food security through pollution.

Water and energy systems efficiency

Water and energy systems are closely interdependent. Water storage, transportation and distribution all rely on energy. The production of fresh water through desalination, which could be an important new source of water in Northern Peru, Northern Chile and the Caribbean, is also highly energy intensive. Given these interdependencies, increasing the efficiency of water-energy systems in domestic and industrial supply and irrigation is therefore an important priority for the decade ahead.

Case Study: Climate Change Adaptation Plan in Huila Department, Colombia

In Colombia, the national Institute for Hydrology, Meteorology and Environmental Studies (IDEAM) has predicted an average temperature increase of 2°C (which may be higher according to more recent global projections) and a 30% decrease in precipitation in Huila Department by 2040. Such a reduction in precipitation would have major impacts not only on water security but also on energy generation (particularly hydropower) and food production, including the Department's 60,000 ha of irrigated rice. This would have significant consequences for the Department's economy, which is based on fisheries, agro-industry and in particular water-intensive fruits, electric energy production and mining.

Water security is also threatened by deforestation in the watershed, primarily driven by agricultural expansion. This affects the headwaters of the Magdalena River, the source of 70% of the country's water, increasing water security risks far beyond Huila Department.

In order to proactively address these threats, the Department has developed a Climate Change Adaptation Plan, using a participatory approach to assess the different needs and trade-offs faced by its citizens and industry alike. The Plan has six interrelated axes for action, consistent with a nexus approach: water, energy, food, ecosystem services, climate and resilient cities. Water is at the heart of the Plan, reflecting its vital importance for Huila and the country as a whole.

The Plan recognises that a key challenge for implementation is establishing a shared vision for climate-compatible development across different institutions and sectors, and harnessing existing regulations and finance more efficiently and effectively.


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Section 4: Looking Forward

Water-energy-food interactions are dynamic, taking place in the context of demographic, economic, political, social, technological and environmental change in the region. Understanding future trends in these areas and the likely impacts on trade-offs and synergies between water, energy and food (identified in section 3) is vital in informing national planning and potential policy responses.

4.1 POPULATION GROWTH AND URBANISATION

The region's population increased from 161 million in 1950 to 547 million in 2005, and is projected to increase to 763 million by 2050[44]. Population distribution has also shifted significantly due to rapid urbanisation. The percentage of the population living in cities has doubled to 80% since 1950 and is predicted to continue to rise. The rapid pace of change and the emergence of mega-cities across the continent has far outpaced urban planning capacity. A high percentage (23%) of the urban population live in slums without affordable access to basic services and infrastructure such as housing, potable water, sanitation, and electricity[45]. This increases the vulnerability of cities to growing threats from climate change and extreme events, including floods, landslides and sea-level rise. In many cases, urban centres have developed from sites originally founded to suit colonial needs and are not well-aligned with water resources. As a result some of the region's largest cities are now facing water scarcity issues, with a number including Rio de Janeiro, Sao Paulo, Mexico City, Lima and Caracas transferring water from neighbouring water basins[46].

Water distribution and sanitation

Urgent investment is required in water provisioning, treatment and sanitation services. Poor sanitation has major impacts on the environment as untreated waste contaminates water bodies. Poor quality infrastructure leads to large water losses across the distribution network, for example in Brazil, the Cities Ministry Agency estimates that these losses reach 37%[47]. Key challenges include weak and fragmented governance, poor management of utilities and water pricing, and low quality infrastructure.

Urban and peri-urban agriculture

Urban and peri-urban agriculture can be important for local food security, both where there are high levels of urban poverty and in the Caribbean where dependence on food imports makes populations vulnerable to global price shocks. A survey conducted by FAO showed that urban and peri-urban agriculture was widespread in the region, including larger urban farming areas such as in Mexico City where 15,000 tonnes of vegetables are produced from 22,800 ha annually[48]. Peri-urban agriculture is threatened from urban sprawl, water competition, and intensive use of agrochemicals.

Urban nexus

Pilot initiatives demonstrate that a nexus approach can provide low-cost solutions in integrated urban planning. For example, waste management issues can be addressed by using waste both for biogas production (for electricity or public transport) and fertiliser for urban agriculture. Treated waste water is being re-used for urban agriculture irrigation in Lima and Mexico (reducing health issues from untreated water), and could also supply household grey water use. Agricultural spaces also help build resilience against floods by increasing permeable space for water to drain. Cities are also looking to their wider environment and recognising the role of natural infrastructure in regulating and purifying their water sources; major cities including Bogota, Lima and Quito have established water funds to compensate watershed protection services by upstream farmers.

4.2 MARKETS

Latin America's role in meeting rising global demand

Latin America's economic growth has been based on primary goods, with raw materials dominating exports. External demand will continue to rise as the global population is predicted to reach 9 billion by 2050. FAO projects that food production will need to increase by 70% by 2050; IEA expects energy demand will increase by 40% in 2030; and OECD predicts a 55% increase in water demands by 2050. Latin America is expected to play a key role in meeting these growing resource demands, as national development plans set out ambitious growth targets for agricultural and mineral exports.

Trade policies

A recent trend of trade liberalisation has stimulated growing exports; there are now 73 Free Trade Agreements (FTA) that involve at least one of the region's countries[49]. However, questions have been raised over the role of such agreements in stimulating economic growth and poverty reduction. In Mexico in particular, NAFTA has exposed farmers to competition from subsidised producers in the USA, resulting in a huge increase in the volume of Mexico's agricultural imports including staple food commodities such as corn.

In a globalised economy, international trade policies, agricultural subsidies, and free trade agreements in one region have impacts in others. For example, research from IFPRI has estimated that policies in industrialised countries, such as domestic support, market protection and export subsidies, costs the LAC region USD$ 8.3 billion in agricultural and agro-industrial income[50].

Price shocks

Global price shocks also have implications for water, energy and food security. During the food crisis in 2007, prices rose substantially faster than the overall inflation rate for most countries in the region with impacts on food security and poverty, especially in Bolivia, Brazil, Chile, Costa Rica, Jamaica, Nicaragua, Trinidad and Tobago, and Uruguay[51]. Similarly, the recent decline in oil prices has important implications for economies in the region that are major exporters such as Bolivia, Ecuador, Colombia, Peru and Venezuela. Oil revenues are normally expected to meet a quarter of revenue needs for Ecuador's domestic budget.

Diversifying economies

Several countries have stated ambitions to diversify their economies and export structures, in order to reduce their dependence on exports of primary goods and decouple economic growth from intensive national resource use. In transforming their economies, Brazil and Mexico have become important industrial players and part of the so-called BRIC and MINT[2] groups of countries. However, moving away from primary-based exports is a greater challenge for countries such as Venezuela and Ecuador that rely heavily on hydrocarbon exports.

Global supply chains

Water (including virtual water embedded in commodities), energy and food supply chains in LAC are influenced by companies, investors and consumers outside the region. Demand-side measures from governments in consumer markets (such as public procurement policies and import tariffs) and companies (including certification, industry standards, and disclosure initiatives) can have major impacts on supply chains in producer regions.

4.3 TECHNOLOGY AND INNOVATION

New and emerging technologies can provide innovative solutions to improve resource management and efficiency across the water-energy-food nexus. Such solutions include providing access to new resources, for example desalinated water and geothermal energy, and re-using existing resources, such as domestic waste water in irrigation and biogas energy from agricultural waste.

However, technological advances that improve efficiencies in one sector can also have negative impacts in others. For example, new irrigation systems that improve water efficiency often require much more energy to operate.

Both the private and public sector are important drivers of research and development in the region. In many countries there is a limited coordination between universities, industry and public funded research. Agricultural research has largely been driven by public research institutions, including EMBRAPA in Brazil, and regional centres of excellence such as the International Center for Tropical Agriculture (CIAT). However, in some countries such as Mexico and Nicaragua agricultural extension services have been privatised; Bolivia now funds agricultural research through four private regional foundations[52]. In addition, there is a need to improve technical assistance and capacity building programmes to support the uptake of new technology by agricultural smallholders.

2. An acronym for Mexico, Indonesia, Nigeria and Turkey, which are expected to show strong economic growth over the coming decade.

4.4 INTERNATIONAL AND NATIONAL POLICY FRAMEWORKS

Sustainable Development Goals

The forthcoming Sustainable Development Goals (SDGs) include ambitious economic, environmental and social targets for 2030 that will shape development efforts for the decade ahead. The 17 proposed SDGs include food (Goal 2), water (Goal 6) and energy (Goal 7), as well as ecosystem services (Goal 15) and climate change (Goal 13). There has been a lot of discussion during the formulation of the SDGs on how to reflect their inherent cross-cutting nature and avoid 'siloed' approaches to implementation. Despite a number of proposals for a more integrated approach, the burden is likely to be on national governments to ensure integration in the implementation of these goals.

Climate Change Mitigation and Adaptation

Under the UNFCCC, COP 21 in Paris is set to define a climate change agreement that will come into force in 2020. Under this agreement, countries in LAC will need to undertake mitigation actions in their agriculture, energy and land-use change sectors, all of which are currently significant sources of emissions. A nexus approach can support the identification of synergies between these sectors and opportunities to optimise mitigation options, for example through increasing the efficiency of coupled water-energy systems, such as irrigation. Integrated planning can also ensure that mitigation and adaptation actions are coordinated across sectors. For instance, whilst irrigation is an important adaptation strategy for agriculture against drought, pumping water is energy-intensive increasing carbon emissions. Similarly, biofuels may support emissions reductions in the energy sector but have impacts on food security through competition for land and water with food crops. Integrating national and local climate adaption plans within traditional sectoral planning will be critical to achieving water, energy and food security.

National development plans

National policies, plans and strategies that set out the vision of governments over a 10 – 30 year horizon are stuck in a siloed approach to water, energy and food. Despite the presence of coordinating mechanisms and institutions, like National Planning Departments, there is a gap in the coherence of policy objectives in the region. For example, in Argentina the 10-year vision for agricultural value chains does not include emissions reductions, although agriculture is a significant source of the country's emissions (44% in 2000[53, 54]).

4.5 ENVIRONMENTAL DEGRADATION: LOSS OF ECOSYSTEM SERVICES

Deforestation

The intensive development of the region's resources has undermined the ecological foundations that underpin the water-energy-food nexus. In particular, agricultural expansion has gone hand in hand with deforestation, biodiversity loss and environmental degradation. From 1990 – 2010, the region lost 92 million hectares of forests, including 55 million ha in Brazil. Whilst tropical deforestation rates in the region have slowed in recent years, mainly driven by a dramatic decrease in deforestation in the Brazilian Amazon from a peak of 2.7 million ha in 2004 to 589,000 ha in 2013, they remain high and are rising in the Andean Amazon.

Ecosystem services

The resulting loss of ecosystem services erodes water, energy and food security at the local and regional scale. At the local scale, provisioning ecosystem services including fresh water, food, raw materials and medicinal plants are particularly important for traditional rural and indigenous communities.

Water security in particular is dependent upon the rainfall recycling, water regulation and purification services of the forest. For example, one study estimates that air travelling over extensive forest cover may generate twice as much rainfall as air over deforested land and that large-scale deforestation is predicted to reduce rainfall by up to 21% by 2050[55]. Deforestation is also likely to affect water quality through increasing soil erosion and leaching of nutrients and heavy metals including mercury[56].

These potential impacts on water security have implications for energy and food security. For example, a recent study suggests that the controversial Belo Monte dam in the Brazilian Amazon, which is projected to supply 40% of Brazil's additional electricity needs by 2019, will have a significantly lower power output than expected due to regional deforestation - up to 13% lower than under a fully-forested scenario, and up to 36% lower by 2050, if current deforestation rates continue[57].

Degraded land

Land degradation is also an important issue in the region. Data from the GLADA Project (Global Land Degradation Assessment and Improvement) indicates that between 1982 and 2002 additional degraded areas amounted to 16.4% of total land area in Paraguay, 15.3% in Peru, and 14.2% in Ecuador. This is predicted to double by 2050 unless current trends are addressed. The situation is worse still in Central America, at 58.9% in Guatemala, 38.4% in Honduras and 29.5% in Costa Rica, with only El Salvador showing a trend in reversal of land degradation[58].

4.6 POLLUTION

Pollution is a key challenge for water security in the region. The main sources of pollution include municipal and industrial waste water discharge, urban run-off, agricultural run-off from fertilisers and pesticides, and the extractive industries – particularly artisanal gold mining in areas such as the Guianas and Madre de Dios Department in Peru, where harmful chemicals including mercury are widely used. Agriculture is an important source of pollution, with nitrogen pollution from fertilisers in LAC contributing 46% of the region's grey water footprint, a key measure of pollution. Brazil and Mexico contribute more than half of this, with maize production in these countries requiring particularly high use of fertilisers.

There is widespread lack of compliance with pollution targets across the region, exacerbated by the absence of monitoring systems for pollutant loads. In Mexico, where the National Water Law establishes water quality limits based on the indicators of biochemical oxygen demand (BOD), chemical oxygen demand (COD), and total suspended solids (TSS), a study in 2009 identified that around 13% of the surface water in the country was polluted.

4.7 CLIMATE CHANGE

Rainfall and precipitation

Climate projections suggest rising temperatures of 1.6 – 4 °C in Central America and 1.7 – 6.7 °C in South America by the end of the century. Whilst there are high uncertainties in rainfall projections, patterns suggest that there will be an increase in rainfall in south-east South America, north-west Peru, north-west Ecuador, and western Amazonia and decreased rainfall in eastern Amazonia, northern South America and Southern Chile[59].

A reduction in precipitation in already vulnerable semi-arid areas will increase water supply risks for cities, hydropower and agriculture.

Tropical glaciers in the Andes

Climate impacts on tropical glaciers in Bolivia, Colombia, Ecuador, Peru and Venezuela are expected to have significant local water, energy and food impacts through changing streamflow. Streamflow is predicted to increase initially due to melting glaciers and then decline as reservoirs empty; for example, in the Cordillera Blanca of Peru seven of nine watersheds show declining dry-season discharge[60].

Extreme events

Extreme weather events have already had significant impacts in the region: from 2000 – 2014 there were 834 of these events across Central America, South America and the Caribbean, resulting in 22,124 deaths and costing USD$ 75.8 billion in damages[61]. Central America is particularly exposed to extreme events; here poverty remains a barrier to climate change adaptation.

Food security

In the short- to mid-term, agricultural productivity could increase in south-east South America and decrease in Central America and north-east Brazil due to the climatic thresholds of different crops. Technological advances, genetic improvements and climate-smart agricultural practices can help farmers mitigate and adapt to climate change, for example through increasing water storage and efficiency.

Offshore fisheries in Peru, Colombia and Chile are particularly vulnerable to climate change, due to rising sea temperatures and productivity shifts in upwelling systems, and the importance of fisheries in diets and economies[62]. The reduction in fish productivity in offshore pelagic fisheries during El Niño years, when changes in pressure weaken trade-winds that normally move warm water away from the coast to enable the upwelling of nutrient-rich cold water that supports fisheries, offers a glimpse of the potential impacts of climate change.

Energy security

Climate and energy are closely linked. Climate change mitigation requires investments in low-carbon energy sources, whilst adaptation requires the diversification of energy matrices, for example, to buffer against hydropower generation vulnerability in the dry season.


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Section 5: Regional Cooperation around Water, Energy and Food Security

The traditional siloed approach to institutional arrangements on water, energy, and food at the national level is also reflected in regional processes and agreements.

However, in promoting regional cooperation, these processes offer an interesting entry point for the nexus approach, with regional trade and integration offering a pathway for countries in the region that lack resources to address water, energy and food trade-offs.

5.1 REGIONAL TRADING BLOCS

The region's trading blocs have developed several strategies and programmes for cooperation on water, energy and food. These include MERCOSUR and CAN, which are united by UNASUR, the Pacific Alliance, NAFTA, and the Caribbean Community (Table 2).

5.2 REGIONAL MULTILATERAL AGREEMENTS

Water security

There are 38 international boundary basins in South America of which only 4 are covered by trans-boundary agreements – Amazonia, La Plata, Lake Titicaca and Lagoon Miram[64]. However, only around 15% of the population are in water basins not covered by a treaty or agreement[65].

The two largest water basins in Latin America, La Plata and Amazonia, are both shared by multiple countries. Both have multilateral treaties to govern their shared use: the La Plata River Basin Treaty, signed in 1969, and the Amazon Cooperation Treaty, agreed in 1979. The La Plata Basin Treaty was established with the goal of promoting the development of the Basin; its success has been seen with the development of 130 dams along the Parana River, including Itaipú. In 2001, the Treaty's Intergovernmental Coordinating Committee incorporated a special unit to address regional problems caused by climate change.

Despite the multilateral treaties similar goals to develop the basin whilst preserving the environment and using its resources rationally, a review of work undertaken by ACTO (the implementation body for the Amazon Cooperation Treaty) concluded that few programmes had actually been implemented. One possible explanation is that while the Amazon Cooperation Treaty includes commitments around shared resources, it is strongly defined by sovereignty over these resources[66].
A USD 52.2 million project implemented by UNEP and ACTO is focussed on Integrated and Sustainable Management of Trans-boundary Water Resources in the Amazon Basin considering Climate Variability and Change. The goals include developing an information system to enhance cooperation and basin management across the 8 countries that share the Amazon basin.

Energy security

OLADE (the Latin American Energy Organisation) was created by member states of the region to support common efforts to achieve regional and sub-regional energy integration and ultimately energy security. Trans-boundary energy agreements in the region include the construction of bilateral hydroelectric projects, such as Salto Grande between Argentina and Uruguay, Itaipú between Brazil and Paraguay, and Yacyretá between Argentina and Paraguay; and trade agreements on the export of oil, natural gas and electricity, such as the Caracas Agreement in 2000, under which Venezuela committed to provide 80,000 barrels of oil per day to 10 Central American and Caribbean countries.
Bilateral energy agreements have sometimes caused conflict, with the controversial Inambari hydroelectric dam proposed under the Brazil-Peru Energy Agreement postponed by the current Peruvian government following large protests.

Regional energy integration - beyond bilateral agreements - has only been achieved in Central America through the Electrical Interconnection System for Central American (SIEPAC). The 6 participating countries, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica and Panama, share a Central American Regional Energy Market (MER) that coexists with national markets. This regional energy market has a regional regulator (CRIE), operator (EOR) and company (EPR)[67].

Food security

IICA (the Inter-American Institute for Cooperation on Agriculture) has a mandate from 34 member states to promote agricultural development and rural wellbeing through technical cooperation. A key strategic goal is to improve the contribution of agriculture to food security. Whilst all countries recognise the importance of family and smallholder farming in supporting food security, the concept of food sovereignty[3] has been enshrined in the constitutions of Bolivia, Ecuador and Venezuela.

5.3 INTERNATIONAL MULTILATERAL AGREEMENTS ON DEVELOPMENT AND THE ENVIRONMENT

Sustainable Development Goals

The Sustainable Development Goals (SDGs) will come into force in 2015. Despite recognition of the interconnections between these goals and the need for an integrated approach to their implementation, the formulation of the SDGs remains very siloed. The nexus approach offers a framework to support governments in understanding the interdependencies between the SDGs, which will be essential for their successful implementation.

Table 2: Cooperation on water, energy and food security under regional trading blocs.

TRADING BLOC	RELEVANT DECISIONS FOR THE WATER-ENERGY-FOOD NEXUS
MERCOSUR	MERCOSUR/CMC/DEC No. 10/98 promotes electrical integration as an important strategy for regional energy security. This is reflected by the 15 energy connections between MERCOSUR members[63].
CAN	CAN has made a number of decisions to promote cooperation on water (Decision 763); energy (Decision 536) and food security (Decision 742).
UNASUR	• The Initiative for the Integration of the Regional Infrastructure in South America (IIRSA) aims to promote regional integration within transport, communications and energy and has developed a portfolio of nearly 600 projects requiring an estimated USD 163 billion of investment. So far more than 100 have been completed. Many of these projects have significant impacts on water, energy and food security through both changing access to markets and impacting ecosystem services. • The South American Energy Council aims to define a South American Energy Treaty with an emphasis on interconnection and trade. However, limited progress has been made with challenges of finance, politics, standardisation and institutional arrangements.

3. The right of peoples and states to define food and agricultural policies.

SUSTAINABLE DEVELOPMENT SOLUTIONS NETWORK (SDSN) AMAZON

SDSN Amazon is a regional initiative (part of the global SDSN Network) that was launched by UN Secretary General Ban Ki-Moon to help implement the Sustainable Development Goals.The goal of this network, led by Fundação Amazonas Sustentável (FAS), is to identify and promote practical solutions to achieve cross-cutting economic, environmental and social goals in the Amazon context. The network aims to build an online database of solutions that can be replicated and scaled by stakeholders in the region.

Multilateral Environmental Agreements

Countries' commitments under Multilateral Environmental Agreements (MEAs) to conserve, restore and protect ecosystems and biodiversity are vital in underpinning water, energy and food systems in the region. Climate change emissions reductions targets under the UNFCCC are also important in promoting low carbon development strategies and associated investment such as the development of renewable energy, including hydropower.

5.4 UNITED NATIONS

The regional offices of FAO, UNDP, UNEP and the Economic Commission (ECLAC) all work on issues relevant to the water-energy-food nexus in supporting governments to achieve sustainable development. In particular, ECLAC is focussing on water security risks in the region and identifying priority topics relevant to the water-energy-food nexus. FAO is active in developing frameworks and tools to address the water-energy-food nexus. The MuSIASEM tool, originally developed for energy analysis, has been extended to consider connections with food and water alongside socio-economic and ecological variables[68].

5.5 MULTILATERAL DEVELOPMENT BANKS

Multilateral development banks play an important role in financing investment in infrastructure and development projects in the region. These include the World Bank, Inter-American Development Bank (IDB), CAF – the Development Bank of Latin America, and the Brazilian Development Bank (BNDES). Whilst all of these banks have environmental and social safeguards, such as the Equator Principles, impacts on water, energy and food are not explicitly recognised.

The IDB is currently investing in the development of decision-support tools to inform lending and investment in relation to the water-energy-food nexus. A review undertaken by IDB shows that existing tools were developed for users in the water, energy or food sectors in isolation, but there is a gap in balanced tools that apply across the nexus.

Table 3: Multilateral Environmental Agreements that impact the water-energy-food security nexus.

MULTILATERAL ENVIRONMENTAL AGREEMENT	RELEVANT DECISIONS FOR THE WATER-ENERGY-FOOD NEXUS
Convention on Biological Diversity (CBD)	**Aichi Targets:** Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced. Target 6: By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches. Target 14: restoration and safeguarding ecosystems that provide essential services including water. Target 15: restoration of at least 15% of degraded ecosystems.
United Nations Framework Convention on Climate Change (UNFCCC)	COP 21 in Paris will define a future climate change agreement to come in to force in 2020. Under this future agreement countries will need to meet their nationally determined emissions reductions targets. This will include emissions reductions in key sectors such as agriculture, energy, land-use change and water. The proposed REDD+ mechanism under this agreement targets emissions reductions from tropical forests.
Ramsar Convention on Wetlands	Wetlands protected by Ramsar Sites: Bolivia: 11 sites, 124,399 km^2 Brazil: 12 sites, 65684 km^2 Chile: 12 sites, 1153 km^2 Colombia: 5 sites, 4585 km^2 Ecuador: 18 sites 2867 km^2 Mexico: 142 sites, 89096 km^2
United Nations Convention to Combat Desertification (UNCCD)	25 countries in LAC have submitted national action plans to combat desertification and land degradation. While Chile and Mexico have not developed national action plans they remain active at the regional level.

Case Study: Amazonia Security Agenda

The countries of Amazonia have harnessed its abundant resources of water, land, and energy to fuel economic growth. However, the intensive development of these resources has led to large-scale deforestation and pollution, undermining ecosystem services and threatening water, energy and food security that are fundamental to flourishing societies and economies in Amazonia and beyond. Climate change is multiplying these threats, and recent extreme droughts and floods in the region offer some insight into the likely challenges ahead.

Meeting these challenges depends on a transition from 'business as usual' to a new model of climate-compatible development and proactive policies and approaches to build resilience to climate change. In Amazonia this requires a move away from historic assumptions of abundance towards a practical understanding of current and evolving threats to water, energy and food security and implications for people and economies in the region.

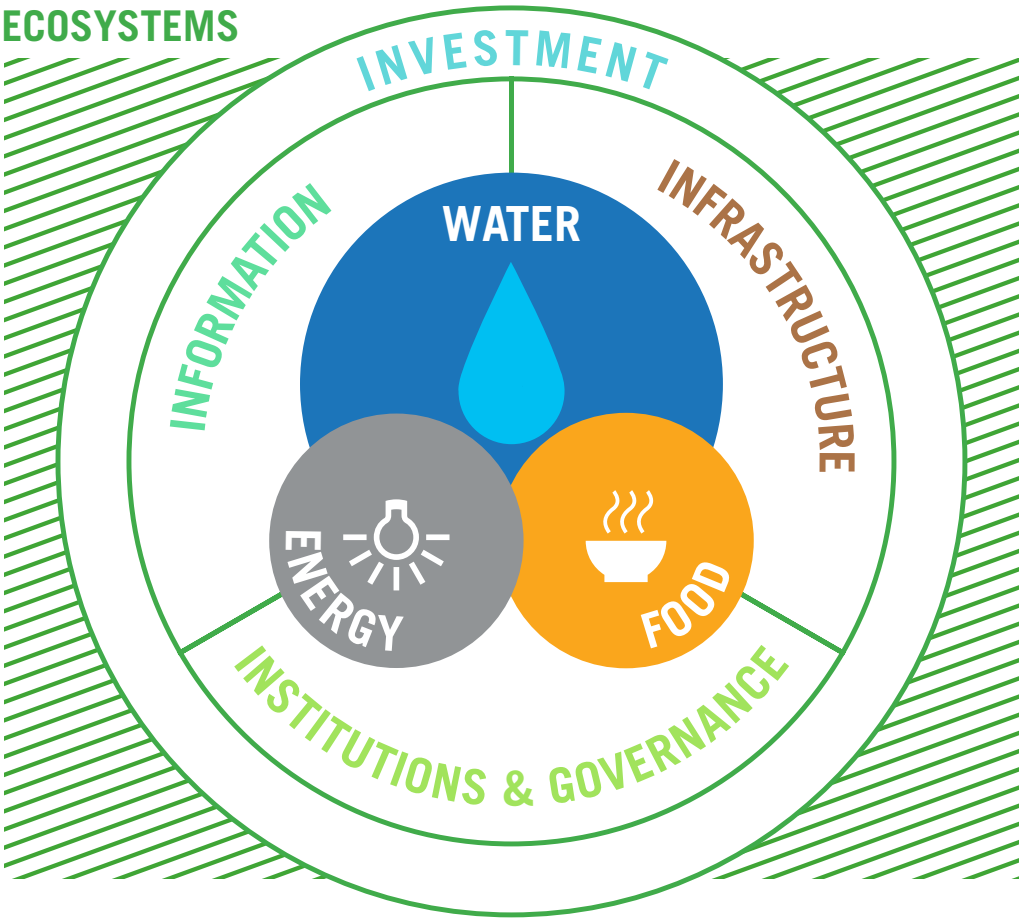
These were the high-level conclusions of the Amazonia Security Agenda (ASA) project, which addresses the Amazonian sustainable development discourse in terms of what matters to Latin American political decision-makers today: people's water, energy, food, and health security.

ASA has developed a platform for dialogue and action around water-energy-food nexus issues in the region: it has synthesised the evidence-base, convened networks of regional institutions working in this space, and engaged with a ministerial-level Advisory Panel from Bolivia, Brazil, Colombia, Ecuador and Peru to identify how regional and sectoral cooperation could help governments address key priorities for safeguarding water, energy and food security. The findings and initial recommendations endorsed by the Advisory Panel were published in a synthesis report in October 2013. The synthesis report, background reports and other materials are available at www.segamazonia.org.

Building on this platform, a second phase of the project will develop practical tools that can support the countries of the region to achieve climate-compatible development in an Amazonia under pressure.

Section 6: Improving Water, Energy and Food Security – a Framework for Action

To help analyse how public and private sector decision-makers can improve water, energy and food security, a four pillar framework based around infrastructure, information, institutions and governance, and investment has been adopted.



INTELLIGENT INFRASTRUCTURE:
How can new infrastructure increase resource-use efficiency, resolve trade-offs, and minimise risks to water, energy and food security?

ACCESSIBLE INFORMATION:
What information and tools are needed to support decision-making?

EFFECTIVE INSTITUTIONS AND GOVERNANCE:
What are the gaps and opportunities to improve the coordination and effective implementation of policies and measures?

TARGETED INVESTMENT:
What economic instruments can promote nexus-friendly investment?

6.1 INFRASTRUCTURE

Infrastructure is critical to enable countries to continue to harness the region's abundant resources and to deliver water, energy and food to its citizens. In LAC there is a significant infrastructure gap within the water, energy, and transport sectors due to low levels of investment[69]. However, there are a large number of planned infrastructure investments in the region. Notably, significant hydropower expansion and the Initiative for the Integration of the Regional Infrastructure in South America (IIRSA) that includes 579 transport, energy and communications projects at a cost of USD 163 billion[70].

Large infrastructure projects can benefit more than one sector: for example, a hydroelectric dam also stores water for irrigation. However, large infrastructure can also negatively impact access to resources in other areas: for example, hydroelectric dams can affect water availability and quality downstream. This can lead to conflict between different resource users, particularly where new infrastructure has a disproportionate impact on local users whilst benefitting distant consumers. In some contexts local solutions, such as micro-hydropower, biogas generators or solar photovoltaic systems, may be much more appropriate than large-scale infrastructure projects.

Large infrastructure is designed with lifespan of at least 20 years and often much longer. This requires a dynamic solutions that are robust and resilient to changes in the climate and demand for resources. A nexus approach in the planning and design of infrastructure can help optimise outcomes across different actors, sectors and scales.

Multipurpose projects

Multipurpose infrastructure projects can help maximise benefits for water, energy and food and minimise conflict between different water users. For example, water storage dams can be used for a combination of irrigation, energy and water supply. This approach is not new in the region; 87% of Brazil's 13,000 dams are multipurpose[71]. Many new multipurpose projects are planned, particularly in the countries that share Amazonia. Examples include Chore, Baba, Río Verde, Olmedo, Yahuarcocha and Chalupas in Ecuador; Chavimochic, Peihap and Olmas in Peru; Rositas, Carrizal and Peñas in Bolivia.

Multipurpose projects often require higher levels of financing than single-purpose projects. Raising finance from sources outside of public funds, for example through PPPs (which are common in the energy sector), is challenging due to greater costs, higher risks, and lower returns. However, in the long term such investments may provide greater benefits to more users. In some cases, existing infrastructure can be adapted to reconcile trade-offs although this is often prohibitively expensive. One example of an adapted multi-purpose project is the development of a fish ladder for the Itaipú dam nearly 20 years after its initial construction.

Water storage and distribution

Agriculture in the region is primarily rain-fed and is therefore vulnerable to changing patterns of precipitation as a result of climate change. Irrigated land in arid and semi-arid regions is also under pressure from reduced water supply. In adapting to climate change, infrastructure investments in water storage and irrigation will be required. These investments could bring additional benefits in enabling dry season agriculture, which is often associated with lower pest loads due to the reduced amount of surface water that acts as a vector. However, these infrastructure investments need to be balanced against the associated energy requirements and, ultimately, the need to grow more with less.

Urban infrastructure innovation

Improving the coverage, quality and accessibility of water distribution, sanitation and energy infrastructure in urban areas is a clear priority. Integrated urban development approaches such as the use of treated domestic waste water for peri-urban agriculture and grey water use; waste in non-conventional energy sources such as biogas; and urban agriculture spaces in flood risk management all offer low-cost solutions that bring multiple benefits.

Integrating climate change risks into infrastructure design and planning

Integrating climate change risks into infrastructure planning – both in terms of mitigation and adaptation - is vitally important, especially considering the long lifespan of infrastructure and the prohibitive costs of adapting infrastructure retrospectively. Within the energy sector, hydropower is particularly vulnerable to climate change. Hydropower planning has previously not included future climate change projections. In Brazil, the recent dominance of run-of-river dams to minimise impacts on local communities leaves hydropower vulnerable in the dry season. To understand climate risks to energy security and inform future investments in its energy matrix, the Brazilian government is funding research into the impacts of climate projections on streamflow and power generation at all existing and planned hydropower installations. A nexus approach can also enable more holistic assessments of technological options in climate change mitigation and adaptation; for example, the introduction of carbon capture and storage (CCS) technology in coal power plants, whilst a priority for cutting carbon emissions, significantly increases water use. CCS is therefore not a viable option in water-stressed regions.

Natural infrastructure

Natural infrastructure, such as forests, floodplains and riparian areas, can provide many of the same services as built infrastructure, including water regulation and filtration, as well as additional benefits, such as carbon sequestration and biodiversity conservation[72]. However, natural infrastructure is often not assessed as a viable option alongside built infrastructure. A nexus approach can support the recognition and evaluation of the multiple benefits of investing in natural infrastructure.

The use of natural infrastructure is well established in Latin America, mainly through Water Funds designed to conserve watersheds that provide hydrological services. The region has 32 Water Funds including the mega-cities of Bogota, Lima, Quito and Sao Paulo (see section 6.4). Furthermore, countries in the region have made significant commitments to preserving and restoring forests and degraded land. All countries in LAC are signatories to the Convention on Biological Diversity (page 28) that aims to conserve, sustainably manage and restore ecosystems. Similarly, many Latin American countries have made significant pledges to restore large areas of forests. Chile, Colombia, Costa Rica, Guyana, Mexico, Peru, as well as Acre State, Brazil, are signatories of the 2014 New York Declaration on Forests, declaring their intent to end natural forest loss by 2030 and to restore 150 million ha of degraded landscapes and forests globally by 2020. Furthermore, at the recent COP 20 in Lima, Initiative 20x20 was launched to restore 20 million ha in LAC by 2020 to support the global Bonn Challenge[4]. Under this initiative, Costa Rica, El Salvador, Colombia, and Guatemala have agreed to restore at least 1 million ha each, whilst the Atlantic Forest Restoration Pact in Brazil also aims to restore 1 million ha.

In meeting these commitments, countries including Brazil and Colombia have national reforestation plans. A nexus approach could help governments to identify priority areas that maximise the benefits for water, energy and food security at the landscape scale. For example, investing in restoring riparian areas that are vital for downstream water security in large urban centres or for hydropower and avoiding areas of high agricultural productivity.

Coherent regional infrastructure planning

Large-scale infrastructure projects are often developed on a case-by-case basis. Even when system-wide expansion plans are drawn up, the most financially viable projects are prioritised. This can lead to sub-optimal prioritisation in terms of water, energy and food security outcomes across the wider region. For example, many countries in the region have ambitious hydropower plans, particularly in the Amazon Basin. Potential sites are ranked by financial viability, and in some cases (such as in Brazil) also according to social and environmental risks. However, this approach does not take these issues into account at a basin scale; for example, future risks under climate change and deforestation scenarios; maintaining connectivity between Andean and Amazon basins; indigenous and protected areas; site-specific demand from mining concessions; and competing water security needs from other industries and populations in the surrounding sub-basin. Prioritisation using a basin-scale approach can support more integrated outcomes for water, energy, food, and ecosystems across a broader region.

Strengthening safeguards

Most countries in LAC have adopted Environmental Impact Assessments (EIAs) as a legal requirement for public and private investment projects[73]. However, EIAs are often used as tools to manage impacts rather than for planning purposes; in many countries, they have effectively replaced regulations on pollution control, land use planning and biodiversity protection[74]. Beyond the public sector, most private sector institutions that finance such projects, including the IDB, the World Bank, BNDES and CAF, also have their own EIA requirements.

4. http://www.bonnchallenge.org/
5. http://www.pactomataatlantica.org.br/

EIAs do not necessarily recognise the full implications of potential environmental and social impacts through the complex interactions between water, energy and food security, local social-economic systems and ecosystem services. For example, site-specific EIAs for hydropower installations do not account for basin-wide issues such as impacts on connectivity.

IMPLEMENTING DECISION-SUPPORT TOOLS FOR NEXUS PLANNING

WATER EVALUATION AND PLANNING (WEAP)

The WEAP tool, developed by the Stockholm Environment Institute, has supported integrated watershed resource planning and management in a number of Andean countries. For example, it was used in the development of the Huila Department Climate Change Adaption Plan in Colombia (see page 17). This tool has been linked with the Long range Energy Alternatives Planning System (LEAP) in moving towards a more integrated nexus analysis. See www.weap21.org for more information.

CARIBBEAN CLIMATE ONLINE RISK AND ADAPTATION TOOL (CCORAL)

CCORAL supports governments, civil society, research, the private and financial sector to integrate climate resilience into their decision making and planning processes in the Caribbean. The tool provides guidance on how to address climate impacts in the context of legislation, national planning, strategy, policy, programmes, projects, and budgets. See ccoral.caribbeanclimate.bz for more information.

LEAST COST ADAPTATION FOR DECREASED HYDROPOWER RELIABILITY IN BRAZIL

The Brazilian energy sector relies heavily on renewable energy sources. Hydroelectric power plants accounted for around 70.6% of Brazil's electric power generation in 2013[77]. The availability and reliability of these renewable sources depend on climate conditions that can vary in light of global climate change. Lucena et al. (2010) applied an integrated resource planning approach to calculate least-cost adaptation measures to a set of projected climate impacts on the Brazilian power sector[78].

Despite the high uncertainty regarding future climate projections, the study showed that to compensate for a lower reliability of hydroelectric production, the Brazilian Interconnected System would need an increased installed capacity able to generate 150-160TWh per year, depending on the GHG emission scenario. The least-cost energy generation matrix to achieve this would be based mostly on natural gas, but also sugar cane, wind power and coal/nuclear plants. The total investment required up until 2035 would be around USD 50 billion.

The tool takes into consideration the whole energy chain and the interactions between energy supply and demand. The indirect effects identified by the study are the displacement of natural gas from other consuming sectors, such as industry, in favour of use for power generation[79]. This methodology is now being expanded to include regional integration options and downscaled climate models to assess climate impacts on run-off and power output at hydropower installations.

6.2 INFORMATION

A sound evidence-base is essential in supporting decision-makers to make an informed assessment in a given context, for instance to quantify the economic and social trade-offs between water, energy and food under different future scenarios and to analyse possible policy responses. The dynamic nature of water-energy-food interactions means that information needs to be timely and available at the relevant scale to decision-makers.

Transparent information systems

Accessible, transparent, timely and comprehensive information across water, energy, food and the environment is essential for nexus decision-making. Relevant data is already collected in the region by governments and regional bodies, including FAO and ECLAC, through satellite observations, censuses and surveys. However, the consistency, quality and availability of data varies across regions and sectors. Overcoming reluctance among different agencies to share datasets is an important priority in improving access to information.

NGOs are playing an important role in increasing the availability and transparency of data. For example, the Amazonian Network of Georeferenced Socio-Environmental Information (RAISG), comprised of NGOs across Amazonia, has brought together information on protected areas, indigenous territories, mineral and petrol concessions, and roads. This one map of the region demonstrates a lack of coherence in land-use planning within countries and across the basin as a whole[75]. Similarly, Global Forest Watch provides information on tree cover change and real-time deforestation alerts across the whole region.

Data gaps

Important information gaps include information on water quality, availability and climate change risks at the local scale. Down-scaling climate-change models from the continent to the local scale, where topographic and environmental variables can have a large impact, is a major challenge. In Brazil, which has high capacity for modelling climate change, the government is funding a number of studies related to energy and health security where downscaled models are being used. For example, FIOCRUZ is developing a national monitoring framework for climate change vulnerability related to health security. As part of this study, climate change models have been downscaled to 20 km^2 and will be run for cities at the 5 km^2 scale. A second study is researching the impacts of climate change on hydropower generation, focussing on water flow changes at specific dam sites.

Monitoring systems

Monitoring systems have been identified as a key priority for the sustainable and equitable allocation and use of resources at the watershed, industry and household scale. Monitoring is also essential for enabling adaptive management through evaluating the implementation and success of policies, investments and technologies.

Decision-support tools

Whilst a nexus approach has been demonstrated to have utility in identifying complex synergies and trade-offs, less focus has been given to implications for policy processes and the development of practical nexus tools and frameworks to support proactive decision-making. Such tools are essential for resolving trade-offs and optimising outcomes across different sectors and stakeholders. In particular, the development of alternative scenarios is an important tool for understanding the potential impacts of different policies and technological investments.

A survey of analytical tools for water-energy-food nexus planning in LAC identified a number of existing sector-specific models. This includes the Water Evaluation and Planning system (WEAP) and Aqueduct tool for water resources planning; the LEAP, MESSAGE, MuSIASEM and MARKAL models for energy systems analysis; and the Global Policy Dialogue Model for food security planning. However, this survey suggests that these models are not appropriate for a fully integrated planning approach at national/local scales due to their focus on a single resource; use of inappropriate scenarios; and a simplified approach[76].

Ecosystem services valuation

The costs, risks, investments, benefits and trade-offs for ecosystems and their services are often treated as externalities that are not accounted for in decision-making. Tools such as inVEST and Co$ting Nature have been developed for economic evaluations of ecosystem services. Even if such assessments are not formally included in cost-benefit analyses, they can still provide evidence for the validity of investing in natural infrastructure or protected areas. In Acre State, Brazil, as part of efforts to transition to a sustainable forest-based economy, the government commissioned a state-wide assessment of ecosystem services to inform its Incentives for Environmental Services (SISA) programme.

Dialogue, capacity building & communication

Access to information and capacity to use this data effectively are both essential in empowering stakeholders to meaningfully participate in decision-making processes around nexus trade-offs and adopt decision-support tools, monitoring systems and new technology. Encouraging the uptake of new tools and approaches is a big challenge, even with successful demonstration projects, and requires effective communications. Novel communication channels with the proliferation of smartphones and networks offers an opportunity to share such information and tools; for example, sharing weather forecasts with smallholders to inform climate-smart agriculture.

PRIVATE SECTOR: UNDERSTANDING RISKS

Corporate and financial actors are major resource users globally. Legal and regulatory frameworks are important tools for resource management, but the private sector has a key role to play in strengthening water, energy and food security. A number of frameworks and tools have been developed to help the private sector to understand and manage resource risks.

CORPORATE DISCLOSURE AND ACCOUNTING

A number of companies in the region have engaged with water accounting and disclosure initiatives including the CEO Water Mandate, CDP Water Initiative, World Business Council for Sustainable Development, and the Water Footprint Network (see Table 2 in Annex 2).

However, members of these initiatives come mainly from companies in Brazil, Colombia and Mexico; two-thirds of companies that are members of the CEO Water Mandate from LAC are based in Colombia. This could reflect the limited outreach and capacity of these initiatives rather than interest from companies, in which case there is great potential for engaging more companies in the region.

WATER RISK VALUATION

The Water Risk Valuation tool is being developed by the Natural Capital Declaration (NCD), a finance sector initiative that is working to support financial institutions integrate natural capital considerations into financial products, as well as in accounting, disclosure and reporting frameworks. Initially focussed on the mining sector (specifically gold and copper), this tool will help portfolio managers to test the impact of water risks on the financial performance of companies. It will evaluate site water use against local water stress to calculate potential losses from disruptions in water supply. This open source tool and methodology will be available for companies and developed for other sectors.

BRAZILIAN BUSINESS AND ECOSYSTEM SERVICES PARTNERSHIP (PESE)

This is a platform for Brazilian companies to proactively develop strategies to manage business risks and opportunities arising from their companies' dependence and impact on ecosystems. It includes capacity building for tools such as the Ecosystem Services Review (ESR),which has been used by the André Maggi Group, a huge soybean producer, to develop a more resilient and economical biomass fuel procurement strategy for their operations in the State of Amazonas.

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6.3 INSTITUTIONS AND GOVERNANCE

National governance strategies continue to address water, energy and food policy in isolation, despite the clear need for an integrated approach. Even where coordination mechanisms and policies are in place, governance gaps lead to an implementation deficit – in particular, weak water governance is a barrier to a nexus approach. Recent water crises in the region have brought this issue to the fore. The upcoming Sustainable Development Goals and UNFCCC Climate Change agreements offer an opportunity for proactive, integrated policies that prioritise longer-term benefits over short-term wins. And whilst implementation and coordination remains a challenge, legislative reform is an entry point for an integrated nexus approach in LAC, particularly given the region's recent history of reforms.

Water governance

Over the last decades, countries in the region have undertaken significant water reforms. These include decentralisation, legal frameworks enshrining the human right to water and sanitation, and the creation of new coordinating institutions and policies, such as National Water Laws and Agencies (see Table 3 in Annex 2). However, many of these reforms are incipient and challenges to implementation remain. Furthermore, gaps such as the governance and regulation of groundwater still exist.

The fragmentation of water policymaking in central government was identified by regional actors as the greatest challenge for water governance in an OECD study[80]. All the 12 countries[6] assessed in this study have multiple central authorities (ministries, departments, public agencies) involved in water policymaking, ranging from 4 in Argentina to 13 in Peru and 12 in Chile. Furthermore, Chile and Peru also have 10 central authorities involved in water regulation. This fragmentation has implications for horizontal coordination across the water-energy-food nexus.

Water policymaking is also decentralised in Latin America, in many cases to watershed management. The mismatch between administrative and hydrological boundaries is an important nexus governance challenge. For example, in Brazil energy is a national security issue with decisions made by central government. Hydropower planning is the responsibility of the National Electric Energy Agency (ANEEL) and the Ministry of Mines and Energy (MME), while the Ministry of Environment (MMA) and National Water Agency (ANA) are responsible for the regulation and protection of water resources in these decisions[81]. However, water regulation is also decentralised to states (25 out of 26 states in Brazil have their own water laws), and water management is run by local River Basin Organisations leading to conflicts between decisions at the local and national scale.

Horizontal and vertical coordination

Water, energy and food are the mandate of separate departments within the region's governments (see Table 4 in Annex 2). Water resources are usually regulated and managed by ministries such as the Environment, Public Works or Agriculture, demonstrating the importance of water across multiple areas of public policy. However, the resulting fragmentation of actors and responsibilities in the public sector represents a serious governance challenge.

In promoting horizontal coordination, most governments in Latin America have implemented mechanisms to facilitate integration between central authorities. Many countries in the region have Planning Departments; either ministries (as in Bolivia, Brazil, Chile, and Costa Rica) or technical public agencies (as in Colombia, Guatemala and Paraguay). In Ecuador and Costa Rica, supra-ministries encompass multiple sectors to avoid conflicting objectives. In Ecuador, the Coordinating Ministry of Strategic Sectors is responsible for coordinating five different ministries including water, electricity and hydrocarbons. In Costa Rica, the Ministry of Environment and Energy, Mines and Water was designed as a single agency to avoid conflicts between different sectoral objectives[82].

Priorities across the water-energy-food nexus can also be defined in legislation. For example, Mexico's new Hydrocarbons Law (as part of wider energy sector reforms) in 2014 prioritises land use for the exploration and extraction of hydrocarbons. However, in this case these reforms lack coherence across the water-energy-food nexus. Mexico has large gas reserves in the north of the country where water is already a constraint, the development of hydrocarbon projects, which require significant water resources, in this region would have major implications for other water users. There are also questions over safeguards for communities, who own/manage large areas of land and compliance, with many examples of companies not following regulations, such as chemical pollution by Grupo Mexico of rivers in the State of Sonora.

6. Argentina, Brazil, Chile, Costa Rica, Dominican Republic, El Salvador, Honduras, Guatemala, Mexico, Nicaragua, Panama, & Peru.

Many countries in Latin America went through a process of decentralisation towards the end of the 20th century. The region now includes 350 states and more than 16,000 municipalities[83]. Water governance tends to be decentralised, with the exception of the Caribbean, with decision-making devolved to local authorities such as River Basin Organisations. However, water regulation is often not devolved to the local level and vertical coordination remains challenging due to the fragmentation of water policymaking across agencies.

Power dynamics and stakeholder dialogues

Power inequalities govern the outcomes of trade-offs between different stakeholders and the viability of different policy responses. Energy security is a key driver in national decision-making and strongly influences water-energy-food nexus trade-offs. For example central government is responsible for defining future energy developments, often at the cost of local watershed scale decision-making. Agriculture, the largest water user, is also a key priority of national governments and there is a strong rural lobby in a number of countries including Brazil. The environment is a clear loser in nexus trade-offs in terms of deforestation, pollution, and the insufficient allocation of water back to ecosystems. In terms of actors, indigenous communities are often marginalised and face local trade-offs from national priorities to develop mineral, land and energy endowments.

A nexus approach requires dialogue between all relevant stakeholders in order to understand different goals, future trends, and acceptable trade-offs. In a regional study of water governance, accountability was identified as a vital governance gap, and in particular the lack of citizen participation in policymaking[84]. However, recent reforms and decentralisation point to progress, for instance through the participation of water-user associations in water policymaking through councils or river-basin organisations.

Bringing powerful stakeholders to the table to address trade-offs with other stakeholders is a challenge, especially where there are few apparent benefits for participating. In many cases a crisis or shock is needed to catalyse their engagement in such a dialogue. For example, Alta Floresta municipality in Mato Grosso State, Brazil was one of 36 municipalities blacklisted in 2008 by the Federal Government for violating deforestation laws. Sanctions included the inability to access rural credit lines and a ban on selling cattle to slaughterhouses for those violating environmental laws. To exit the blacklist 80% of the municipalities' properties would need to be registered on the CAR Cadastre and forest restoration plans would need to be in place. In 2010, Alta Floresta was hit by a severe drought despite having 3,500 water springs. This shock demonstrated to agricultural and livestock producers the value of restoring riparian areas around water sources and enabled a dialogue and a new coalition between the rancher association (a previously unengaged stakeholder), the municipality government and Instituto Centro de Vida (an NGO). The coalition received funding from the Amazon Fund to map properties on to the CAR system, set up monitoring, and support farmers with restoration efforts around springs, and pilot demonstration units for sustainable agriculture. Alta Floresta was removed off the blacklist in 2012. The twin crises of the blacklist and drought led to a dialogue between different actors and investment in water security through both restoring riparian areas and transitioning towards a deforestation-free economy. However, incentivising pro-active multi-dialogues remains a challenge.

Access to resources: Land and water rights

Access to resources that underpin water, energy and food security are governed by land tenure and property rights. There is a high level of inequality and concentration of land ownership in Latin America; for 1986-90, the Gini index (a measure of inequality) for agricultural land ownership was 0.81, higher than the global average of 0.65[85]. Land titling processes over the last 30 years have led to a large increase in the area of titled indigenous territories and lands; for example, Indigenous Territories now cover 27.5% of Amazonia. However, these areas remain under pressure from other land uses. In the same region, 11% of oil blocks and 18% of mining concessions overlap with officially recognised Indigenous Territories[86].

There have been high levels of foreign investment in land and agriculture in countries across the region, particularly through transnational Latin American companies. Moreover, one study estimates that land grabbing has occurred in 10 countries in the region[87].

Water is defined as a public good in the region; as such, the state plays a central role in managing, allocating, and monitoring water use. Water rights are defined by national water laws. The allocation of water use rights to individuals/corporations is conditional on beneficial and effective use and no harm to the environment or third parties. Chile has a unique model in the region, whereby water rights can be traded in a water market (page 43). The LAC region is a pioneer in the recognition of the human right to safe drinking water and sanitation, which is

INTEGRATED WATER RESOURCES MANAGEMENT

Integrated Water Resources Management (IWRM) has a long tradition in the region as a model for water governance, particularly in Argentina, Brazil, and Mexico. There is consensus among water authorities in the region that this is a good way to enable adaptive water management. It is therefore an interesting entry point for the nexus approach.

IWRM models in the region are focussed at the watershed level and involve both water authorities and water user councils (or River Basin Organisations). Water user councils include representatives of each user or sector, as in the case of Peru where both agrarian and non-agrarian users are represented. River Basin Organisations exist in a number of LAC countries including Brazil, Chile, Mexico, Argentina, El Salvador, Dominican Republic, Guatemala, Nicaragua and Peru. These vary in maturity, with Peru piloting River Basin Councils as recently as 2010.

However, there are many governance challenges to effective implementation in the region. Reaching consensus among different stakeholders is a difficult and time-consuming process; for example, in Mexico 26 watershed councils have been established, but an agreement has only been reached in one council. There is a gap between research and IWRM management, which often remains a theoretical concept rather than a practical outcome. In Peru, La Molina University (UNALM) had a mandate to inform national water management policy, but in practice this was not utilised by decision-makers in the government. Vertical coordination is challenging due to the fragmentation of water policymaking in central government. Furthermore, governance is primarily carried out according to administrative boundaries/political units, which rarely align with geographical watershed boundaries. This is reflected by the fact that while River Basin Organisations are responsible for planning and monitoring, none have regulatory powers. This administration gap was highlighted as an important challenge in the OECD's study on water governance in countries with River Basin Organisations. This challenge is also mirrored at the trans-boundary scale, for example in the Amazon and the La Plata Basins.

A nexus approach offers a new perspective for improving the design and implementation of IWRM, with a greater focus on water, energy and food security outcomes. Successful IWRM case studies can also inform the implementation of a nexus approach. For example, in the Huasco basin the 'Junta de Vigilancia del Río Huasco y sus afluentes' (JVRH) water association established in 2004 has implemented a highly successful irrigation and water management system in a water-stressed region in the Atacama. The introduction of a volumetric water allocation distribution system for irrigation, a monitoring system, and good communication strategy has resulted in large improvements in efficiency, which have enabled water to also be allocated to a run-of river hydropower plant that is expected to raise USD 7.7 million a year.

now recognised in the legislation of 15 countries in the region. However, in 2011 more than 100 million people still did not have access to improved sanitation services and more than 30 million did not have access to safe drinking water[88].

A number of water conflicts have occurred in the region over the right to water, including the high-profile Cochabamba Water War. As climate change is predicted to increase shortfall of water in some areas, the frequency of such conflicts is predicted to rise.

Ambitious goals under new international development and environment agreements.

The Sustainable Development Goals (SDGs) offer an opportunity to embed a nexus approach in countries' implementation plans. Colombia has led the way in promoting an integrated planning approach to the SDGs[89, 90]. The Colombian government adopted a participatory, nexus approach in the formulation of the country's SDG framework that will support alignment of policy with the global post-2015 agenda. This approach focuses on targets rather than goals to avoid a narrow sectoral perspective; in reflecting the interconnections between the economic, environmental and social issues, targets are expected to be relevant under more than one SDG. In implementing this approach, each government agency presented their top three priorities in relation to achieving the SDGs. This led to shared targets; for example, the Ministry of Mines and Energy's target to formalise the mining sector was shared by 11 agencies. The National Planning Department is taking forward this approach in coordinating the implementation of the SDGs.

At the upcoming UNFCCC COP 21 in Paris, countries will define a new climate change adaptation and mitigation agreement that will come into force in 2020. Under this agreement, countries in LAC will need to mitigate climate change emissions in key sectors, which will include energy, agriculture, and land-use change, and adapt to build resilience for their economies and populations. Countries in the region have already taken steps to develop climate change strategies and associated institutional arrangements.

However, a review of the quality and state of public policies on climate change in Latin America concluded that there is a serious deficit in the implementation of these policies, and in particular weak coordination with other sectoral and macroeconomic policies. For instance, even with the high-profile low-carbon agriculture ABC programme in Brazil, its budget is significantly lower (3.15 billion Reals in 2011-2012) than for traditional agriculture (107.2 billion Reals in 2011-2012)[91]. The new agreement in Paris offers the political opportunity to address these issues in the region.

6.4 INVESTMENT

A wide variety of economic instruments can promote investments in the nexus approach; for example, incentives to improve resource-use efficiency or tools that internalise externalities and reflect the true value of resources. Reviewing and removing existing harmful economic instruments, such as subsidies that result in inefficient resource use, is also important.

This section provides a brief assessment of economic instruments in the region that can promote nexus-friendly investment: both market mechanisms, including PES, taxes and fees, and non-market mechanisms, such as grants, subsidies and budget allocations. The feasibility of each mechanism is dependent on enabling conditions, which vary across different country contexts – for example, Bolivia, Ecuador, Nicaragua and Venezuela are opposed to the use of market mechanisms for environmental goods and services, such as water or carbon. Other enabling conditions that are important for the generation, management and delivery of finance include legal frameworks, compliance, human capital, good governance and transparent monitoring systems.
Investment is needed in institutions, information and infrastructure to help meet increasing demand for water, energy and food and to transition to more sustainable and low carbon approaches. Crucially, investments and economic incentives need to be aligned across the water-energy-food nexus to avoid unintended outcomes - for example, subsidies that distort prices and lead to inefficient resource use. Attracting private sector investment will be important to meet the required levels of funding

Payments for Ecosystem Services

Payment for Ecosystem Services (PES) internalises environmental externalities that are not captured in existing markets. In doing so, PES directs investment into ecosystems and watersheds that underpin water, energy and food systems. For example, a downstream hydroelectric company could pay upstream farmers to maintain watershed services. PES programmes can be established at the watershed, regional or national scale, but clear property rights over who has the right to use and sell ecosystem services must be defined.

LAC is a global leader in PES. Whilst the majority of PES schemes are at the local scale, there are also national PES programmes in the region (see Table 2). Legislation in a number of countries enables PES programmes to be designed. This includes Peru's new Payments for Ecosystem Services Law, a number of states and municipalities in Brazil, including Amazonas and Acre State; and Colombia's National Policy for Integrated Water Resource Management, which requires municipal and department entities to direct 1% of annual revenues towards conserving watershed services.

Funds

Water Funds are a type of Payments for Ecosystem Services scheme. These trust funds finance watershed services by compensating those who preserve and restore forests and grasslands in riparian areas. The Latin America Water Funds Partnership, a public-private partnership of The Nature Conservancy (TNC), the FEMSA Foundation, the Inter-American Development Bank (IDB) and the Global Environment Facility (GEF), was developed to provide technical and financial support for new and existing initiatives in the region. Capitalised by USD 27 million, the fund aims to support 32 Water Funds that conserve 7 million acres of watersheds and secure drinking water for 50 million people. This includes major cities in the region such as Bogota, Lima, Quito and Sao Paulo. In Quito, the FONAG Fund makes annual payments of around USD 1 million to protect the surrounding watersheds.

Mainly capitalised by governments and international donors, private sector actors including water utility, hydroelectric and beverage companies are also providing funds to compensate upstream conservation activities in recognition of their role in providing water security. In Bogota, the beverage company SAB Miller has invested USD 150,000 for upstream watershed conservation activities to protect against rising production costs for water treatment.

The Amazon Fund in Brazil is managed by the Brazilian Development Bank (BNDES). Its mandate is to raise donations for non-refundable investments in preventing and monitoring deforestation and promoting sustainable forest use and conservation in the Amazon Biome. Donors include the Norwegian and German governments and PetroBras, Brazil's semi-public multi-national energy company.

INVESTMENT IN INFRASTRUCTURE TRENDS

Latin America currently spends around 1.7% of GDP on infrastructure, which is low in comparison to global trends. One study by CG/LA suggested that a 250% increase in investment is required within the next five years for GDP to increase by 3% over current trends. Important areas of investment include sanitation, hydropower, and irrigation, where investment needed by 2030 has been estimated at up to USD 3.7 billion[93].

In many cases, public sector finance is required for infrastructure projects, particularly for irrigation and water where returns are expected to be minimal. Despite the challenges of attracting private sector investment, investment in water and sewerage infrastructure projects involving the private sector totalled USD 14.4 billion in LAC from 2004 – 2013, whilst investment in energy infrastructure in the same period totalled USD $165.5 billion (World Bank, PPI data).

Beyond built infrastructure, Latin America is a leader in natural infrastructure investment. In 2014, over 6.1 million ha in the region were managed for watershed services, with an annual transaction value of USD 84.9 million[94]. Again governments are the main investors, particularly through large PES programmes in Ecuador and Mexico, with the private sector only paying 1% of the costs.

Investment in natural infrastructure is still dwarfed by built infrastructure. Demonstrating a good return on investment from natural infrastructure is vital to make it a viable option to either complement or replace traditional built infrastructure.

Table 4: National PES Programmes in LAC

COUNTRY	PES PROGRAMME
Costa Rica	Costa Rica's national PSA (Pagos por Servicios Ambientales) compensates forests owners for conserving, managing or restoring forests. It is based on 1996 Forest Law 7575 which recognised that forests provide 4 types of services i) climate change mitigation, ii) hydrological services, iii) biodiversity protection and iv) scenic beauty for ecotourism & recreation. Funds are raised from 3.5% of revenues from a fossil fuel tax (around USD 10 million/yr); ODA; and a levy on water payments through a conservation fee. By 2008 10,000 contracts had been awarded totalling USD 206 million and covering 668,339 ha of land. In promoting uptake from poorer farmers with smaller holdings in 2004 reforms to PSA gave preference to applications from regions with a low Social Development Index. These regions now represent 25% of all contracts.
Mexico	A national payment for hydrological services scheme, PSAH (Pagos por Servicios Ambientales Hidrológicos), was established in 2003 to address water security issues by paying locals to conserve forests under threat of deforestation from revenue raised from national water fees. More recently in 2008 a more locally focussed scheme, MLPSA-FC (Programa de Mecanismos Locales de Pago por Servicios Ambientales a través de Fondos Concurrentes), was developed which has signed 94 agreements covering a total area of 348,414 ha worth USD 7.4 million.
Ecuador	Socio Bosque is an economic incentive scheme for the conservation of native forests and páramo by campesinos and indigenous communities. In 2014 1.4 million ha under conservation. Depending on the area under the scheme funds vary from $60/ha for participants with under 20 ha to $0.5/ha for more than 10,000 ha. Funding is mainly provided by the government.
Brazil	Produtor de Agua led by ANA provides financial and technical support for the creation of local usage fees to fund conservation of priority river basins managed by basin committees. At the end of 2013, the program consisted of 19 projects covering a total area of 306,000 ha.

Cap and trade markets

In Chile, the national water code has established transferable water rights. This has enabled a water trading system whereby the cost of water rights reflects the opportunity costs of water and thus moves rights from lower to higher value users. The market operates through a tax for unused rights and a registration and approval system regulated by Water User Associations. Data indicates that this market is worth more than USD 1 billion a year, and that water rights have a higher economic value in the north of the country where water is scarcer. Mexico also has a water market, although through a different system of transferable water-use concessions, which can be granted to water-use associations, individuals or incorporated firms for up to 50 years[95]. Challenges for water markets include building in resilience and future sustainability, which is threatened by the over-allocation of water in the context of a changing climate. However, due to existing water legislation in the region, water markets are unlikely to be applicable outside of Chile[96]. Furthermore, a number of countries including Bolivia, Ecuador, Nicaragua and Venezuela have explicitly rejected the privatisation of water.

Green commodities

Green commodities bundle consumer demand for ecosystem services into existing international markets for commodities such as coffee or palm oil. Green commodity markets could help the region to decouple agricultural commodity production from deforestation. Recent commitments to zero-deforestation supply chains by a number of high profile companies, such as those in the Consumer Goods Forum, have provided momentum for sustainable commodity production including beef, palm oil and soy. Whilst sustainable commodity production is not yet clearly defined and is often linked to avoided deforestation, Kelloggs has announced moves to source rice from producers adopting climate-smart agriculture practices (that include water and energy efficiency criteria)[97].

Tariffs and fees

Low water pricing means that the costs of water supply and sanitation service provision are not fully covered in the region and are often financed through state subsidies. Water cost recovery is also an issue in agricultural irrigation systems. This results in inefficient water use and a lack of investment in infrastructure, which can compound the problem through water losses. Challenges to efficient water pricing include rising energy prices, a lack of water meters in households, and the need for social tariffs that enable all users to access their basic right to water. Progressive approaches to water pricing include a rebate for efficient use in Peru and variable pricing by regional availability in Mexico. However, in the case of Mexico, despite variable pricing by zone and user, there is no tariff for irrigation within water-use concessions and the low tariff for exceeding water-use limits in concessions does not vary by zone[98].

In financing sanitation costs, the Polluter Pays Principle has been applied in a number of countries. Colombia introduced a Discharge Fee in 1997 for water pollution; following problems with compliance a new Decree (3100) introduced pollution reduction targets and a requirement for pollution management plans. In Costa Rica, a similar Environmental Fee for Discharges was introduced in 2009, which has also faced challenges over compliance.

Colombia's Discharge Fee programme was based on the 1993 Law 99. This law also included a requirement for projects which directly use water from natural sources and are subject to an environmental license to earmark 1% of the total project investment towards the recuperation, preservation and monitoring of the respective watershed. However, following a review that demonstrated limited compliance, the law was clarified in 2006 (Decree 1900), making it a legal requirement for projects to present a plan for the allocated 1% of funds which must be aligned with priorities of the respective Water Basin Development and Management Plan.

Royalties, a levy on the extraction of non-renewable resources such as fossil fuels and minerals, are an important source of revenue in the region. Royalties normally represent 1 – 5 % of concession revenues, although they exceed 10% in Colombia. Royalties are often centrally hypothecated with some redistribution to extractive regions. However, in Colombia recent royalty reforms have transformed the royalties system from directly allocating 80% of revenues to regions where the extractive industries were operating to allocating only 10% of royalties to these regions in 2014. Royalties are now targeted at regional development in the poorest regions (40%) and science and innovation (10%). This offers an opportunity for royalties to be harnessed for improving water, energy and food security and compensating for water quality impacts from extractive industries.

Tax incentives

Tax incentives can be used to promote nexus friendly behaviour by companies and land users. Whilst a unique example, the free trade zone introduced by Manaus city in the heart of the Brazilian Amazon highlights the potential impacts that tax incentives can achieve. These tax incentives helped push the economy towards the services sector and away from primary sector and resource-extractive industries such as timber, agriculture and livestock, with services accounting for more than half of economic output in 2008. However, Manaus' market share in industries such as IT goods is coming under pressure from other states and cities. New incentives in sustainable forest products, such as PES and REDD+, may be needed to stimulate further investment and avoid its economy moving back to a resource-extractive focus[99].

Taxes can also be used to punish harmful behaviour. However, LAC has a low tax burden and raising taxes is not likely to be a viable option, especially given the challenges of ensuring compliance. Nevertheless, in 2014 Chile introduced a new carbon tax for industrial power plants promoting lower carbon energy generation.

Private investment and PPPs

Water scarcity in Chile has led to private investments by industry to secure new water supplies rather than draw on the limited available supplies that are essential for local people. BHP Billiton and Rio Tinto have invested USD 3 billion in a desalination scheme for their Escondida copper mine in Chile. Seven other mining groups in the country have drawn up plans for smaller desalination plants worth a combined USD 1 billion.

To attract private sector investment a number of countries and states have developed legal frameworks to enable PPPs. This has been particularly successful in Brazil, Chile, Colombia and Mexico (which passed a new PPP law in 2013)[100]. Novel approaches to attracting investment include Acre State in Brazil's SISA programme, which has created the Company for Development of Environmental Services, a public-private, mixed capital company, with the role of attracting public and private investments for the sustained provision of environmental services.
Similarly, there have been legal reforms to encourage foreign direct investment (FDI), which reached a new all-time high in the

region in 2013, at USD 188.101 billion. Investments in natural resources comprised 26% of the total, mainly in the hydrocarbon and mining industries. FDI in natural resources in Central America, the Guianas and the Caribbean is expected to rise as these countries develop large extractive projects. Whilst Europe and the USA are the largest investors, trans-national Latin American companies also play an important role, particularly in Central America and Colombia[101].

However, to date private investment has not been sufficient to bridge the public sector investment gap in infrastructure. The lack of private sector interest in the Belo Monte dam is a case in point: low returns from controlled tariffs, coupled with high social and economic risks in a controversial project, put off prospective investors.

Development banks

Development banks, including BNDES, CAF, and IDB, play an important role in financing infrastructure projects in the region. For example, BNDES has provided R$ 22.5 billion for the Belo Monte plant. Meanwhile IDB is providing USD 2.8 billion for IIRSA transport, energy and communications projects (28% of the total value of these projects)[102]. Strengthening the lending criteria of these banks to reflect a nexus approach would be useful. This could build on existing standards such as the Equator Principles, employed by 13 banks in the region, which includes safeguards around the sustainable management of natural resources and the need to engage with all relevant stakeholders.

Domestic credit lines

Credit lines are an important source of domestic finance, particularly in the agricultural sector. For example, in Colombia, FINAGRO issued agricultural loans worth USD 3.6 billion in 2012. These credit lines provide an opportunity to incentivise best practices such as low-carbon agriculture or irrigation efficiency. In Brazil, the availability of credit and loans is linked to the National Agro-Ecological Zoning of Sugarcane, which aims to promote the expansion of biofuels in productive zones where the least irrigation is required and away from ecologically sensitive areas[103].

Subsidy reform

Subsidies are introduced by governments to promote economic growth, employment, accessibility to services, and increased production. Subsidies in different forms are present across the water, energy and agriculture sectors in the region. Fossil fuel and electricity subsidies in LAC were estimated at around 1.8% of GDP from 2011-2013[104]. Fossil fuel subsidies are particularly high in oil rich countries such as Venezuela, which the International Energy Agency (IEA) estimated to be worth more than USD 30 billion in 2013[105]. In comparison, electricity subsidies tend to be higher in Central America and the Caribbean.

Subsidies can lead to negative outcomes across the nexus by distorting the price of resources and encouraging inefficient resource use. For example, in Mexico electricity subsidies for pumping groundwater act as an incentive to pump water and lead to the degradation of aquafers[106]. A clear priority is removing such harmful subsidies and, where possible, redirecting finance to incentivise activities that promote efficient resource use and support positive outcomes across the water-energy-food nexus.

Grants and loans

International grants and loans through official development assistance (ODA) and other official flows provide an important source of finance for governments in the region. For example, in the water sector alone LAC received around USD 22 billion during 2000-2011 from international public investment; this included USD 1500 million from The Spanish Fund for Water and Sanitation in Latin America to achieve the human right to water and sanitation in the region[107].

Mitigation and adaptation funds under a future UNFCCC global climate agreement will be an important source of funding from 2020 for the water, energy, agriculture and land use sectors in the region. In the interim period, the Green Climate Fund will support developing countries with climate change finance. Bilateral agreements can also provide funding for climate change, such as the Norway-Peru and Norway-Guyana agreements for performance-based payments for avoided deforestation, worth up to USD 300 million and USD 250 million respectively.

The Sustainable Development Goals are also likely to act as a channel for international finance flows for water, energy and food security up to 2030.

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ANNEX 1

INTERVIEWEES:

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ANNEX 2

Table 1: Estimates of hydropower capacity and potential in South and Central America. From: IEA (International Energy Agency) 2012. Technology Roadmap: Hydropower. Paris, OECD/IEA

South America				
Country	Reference year	Hydropower potential (MW)	Installed capacity (MW)	% of potential
Argentina	2007	40 400	9 934	25%
Bolivia	2006	1 379	484	35%
Brazil	2010	260 093	80 703	31%
Colombia	2007	96 000	9 407	10%
Equator	2008	30 865	2 064	7%
Guyana	2010	7 600	n.a.	n.a.
Paraguay	2003	12 516	8 350	67%
Peru	2006	58 937	3 067	5%
Suriname	1994	2 420	n.a.	n.a.
Uruguay	2006	58 937	3 067	5%
Venezuela	2002	46 000	28 725	62%
Sub-total	583 181	149 227	n.a.	26%
Central America and Caribbean				
Country	Reference year	Hydropower potential (MW)	Installed capacity (MW)	% of potential
Costa Rica	2008	66 333	5 013	76%
Cuba	2002	650	43	7%
Dominican Republic	2010	2 095	472	23%
El Salvador	1995	2 165	486	22%
Guatemala	2008	5 000	786	16%
Haiti	2009	137	65	47%
Honduras	2006	5 000	520	10%
Jamaica	2009	24	23	98%
Mexico	2005	53 000	11 619	22%
Nicaragua	2008	1 767	109	6%
Panama	2010	3 282	1 106	34%
Subtotal	79 753	20 242	n.a.	25%

Table 2: Companies based in the LAC region that are engaged in Water Accounting and Disclosure Initiatives. Updated from: Willaarts, B., Garrido, A. & Llamas, R. (Eds.) Water for Food Security and Well-being in Latin America and the Caribbean. 2014, Earthscan.

Name	Sector	Country	Initiative
Nabors Industries Ltd.	Energy	Bermuda	CDP – Water Initiative
Ingersoll-Rand Co. Ltd.	Industrials	Bermuda	CDP – Water Initiative
Aquarius Platinum	Materials	Bermuda	CDP – Water Initiative
Natura	Cosmetics	Brazil	WFN/WBCSD
FIBRIA	Pulp	Brazil	WFN/WBCSD
Cimentos Liz	Cement	Brazil	WBCSD
Abril Group	Media	Brazil	WBCSD
Petrobrás	Oil	Brazil	WBCSD
Suzano Papel e Celulose	Pulp and paper	Brazil	WBCSD
Votorantim	Cement, metals, energy, steel, agribusiness	Brazil	WBCSD
Banco do Brasil	Banking	Brazil	The CEO Water Mandate
Vale	Mining	Brazil	CDP – Water Initiative – WBCSD
Cia. Siderurgica Nacional – CSN	Steel	Brazil	CDP – Water Initiative
SANASA	Banking	Brazil	CEO Mandate
Intercement	Cement	Brazil	WBCSD
Ambev - Cia de Bebidas das Américas	Consumer Staples	Brazil	CDP – Water Initiative
Petróleo Brasileiro SA - Petrobras	Energy	Brazil	CDP – Water Initiative
Cielo SA	Information Technology	Brazil	CDP – Water Initiative
BRF S.A	Consumer Staples	Brazil	CDP – Water Initiative
JBS S/A	Consumer Staples	Brazil	CDP – Water Initiative
Marfrig Alimentos S.A.	Consumer Staples	Brazil	CDP – Water Initiative
Braskem S/A	Materials	Brazil	CDP – Water Initiative
Cia. Siderurgica Nacional - CSN	Materials	Brazil	CDP – Water Initiative
Duratex S/A	Materials	Brazil	CDP – Water Initiative
Klabin S/A	Materials	Brazil	CDP – Water Initiative
Quimica del Campo	Metals	Chile	WFN
Vinã Concha y Toro	Wine	Chile	WFN
Codelco	Mining	Chile	WBCSD
Masisa	Timber	Chile	WBCSD
Empresas CMPC	Pulp and paper	Chile	WBCSD
Colbun SA	Utilities	Chile	CDP – Water Initiative
S.A.C.I. Falabella	Consumer Discretionary	Chile	CDP – Water Initiative
EPM Group	Energy and water	Colombia	WBCSD
Grupo Nutresa	Food	Colombia	CEO Mandate
Ecopetrol	Oil	Colombia	CDP - Water Initiative - CEO Mandate
Bavaria	Brewing	Colombia	CEO Mandate
Celsia	Energy	Colombia	CEO Mandate
Cementos Argos	Cement	Colombia	CEO Mandate
Empresas Publicas de Medellin	Water, energy and gas	Colombia	CEO Mandate

Table 2. Cont.

Name	Sector	Country	Initiative
Famoc Depanel	Consumer Staples	Colombia	CEO Mandate
Grupo Argos	Cement, energy, urban and real estate dev.	Colombia	CEO Mandate
Isagen	Energy	Colombia	CEO Mandate
Postobón	Beverages	Colombia	CEO Mandate
CEMEX	Cement	Mexico	WBCSD
Walmart de Mexico	Retail	Mexico	CDP – Water Initiative
Fresnillo	Mining	Mexico	CDP – Water Initiative
Grupo Mexico S.A.B. de CV	Materials	Mexico	CDP – Water Initiative
Grupo Televisa S.A	Consumer Discretionary	Mexico	CDP – Water Initiative
Agricola Chapi	Agribusiness	Peru	CEO Mandate
Southern Copper Corporation	Materials	Peru	CDP – Water Initiative
F.M. Contracting & Services	Services	Trinidad & Tobago	CEO Mandate
Trade & Industrial Development Ltd	Trade	Trinidad & Tobago	CEO Mandate

Table 3: Companies based in the LAC region that are engaged in Water Accounting and Disclosure Initiatives. Updated from: Willaarts, B., Garrido, A. & Llamas, R. (Eds.) Water for Food Security and Well-being in Latin America and the Caribbean. 2014, Earthscan.

Country	Water Authority	Start year	Chief Authority
Brazil	National Water Agency	2000	Under Environment Ministry
Peru	National Water Authority	2008	Under Agriculture Ministry
Ecuador	National Secretary of Water	2008	Under President's Office
Colombia	Department of Integrated Water Resources Management	2011	Under Environment Ministry
Venezuela	Vice-ministry of Water	2003	Under Environment Ministry
Bolivia	Ministry of Environment and Water	2006	Under President's Office

Table 4: Government ministries responsible for water, energy and food. From: Willaarts, B., Garrido, A. & Llamas, R. (Eds.) Water for Food Security and Well-being in Latin America and the Caribbean. 2014. Earthscan

Country	Water	Energy	Food
Argentina	- Department of Public Works - Sub-department of Water Resources - Ministry of Federal Planning, Public Investment and Services	- Ministry of Federal Planning Public Investment and Services - Department of Energy	- Ministry of Agriculture, Livestock and Fishing
Bolivia	- Ministry of Environment and Water Resources	- Ministry of Energy and Hydrocarbon	- Ministry of Rural Agricultural Development and Environment
Brazil	- Ministry of Environment - National Water Agency	- Ministry of Mining and Energy	- Ministry of Agrarian Development - Ministry of Agriculture, Livestock and Supply - Ministry of Fishing and Aquaculture - Ministry of Social Development and Fight Against Hunger
Chile	- Ministry of Public Works - Water Department - Ministry of Agriculture	- Ministry of Energy	- Ministry of Agriculture
Colombia	- Ministry of Environment, Housing and Territorial Development - Vice-Ministry of Water and Sanitation	- Ministry of Mines and Energy	- Ministry of Agriculture and Rural Development
Costa Rica	- Ministry of Environment and Energy - Water Direction	- Ministry of Environment and Energy	- Ministry of Agriculture and Livestock
Ecuador	- Ministry of Urban Development and Housing - Sub-ministry for potable water and sanitation - Ministry of Strategic Sectors	- Ministry of Electricity and Renewable Energy - Ministry of Non-Renewable Natural Resources - Ministry of Strategic Sectors	- Ministry of Agriculture, Livestock, Aquaculture and Fisheries
Peru	- Ministry of Agriculture - National Water Authority	Ministry of Energy and Mining	- Ministry of Agriculture
Mexico	- National Water Commission (CONAGUA) - Department of Environment and Natural Resources	- Department of Energy - Secretary of Energy	- Department of Agriculture, Livestock, Rural Development, Fishing and Food

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