ATLANTIC FUTURE

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Regional environmental challenges and solutions in the Pan-Atlantic Space

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ABSTRACT

The pan-Atlantic is not an abstract of international relations, but is a biophysical reality. We examine the Atlantic-specific, regional dynamics of global environmental challenges and solutions, considering whether the interconnected Atlantic space helps to resolve, or instead worsens, these and how the natural and human linkages within the Atlantic Basin intersect in regional governance. The pan-Atlantic and its sub-structures are found to be useful units of analysis for understanding and addressing environmental challenges. Beyond a shared physical environment, Atlantic countries also share common histories and starting points, which may serve as the basis for inter-Basin cooperation in resource management challenges.

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1. Introduction

The pan-Atlantic is not an abstract of international relations, but is a biophysical reality. While an "Atlantic Space" may appear as a perception of international relations, it is in fact already maintained by natural links. Patterns of resource extraction, trade, and consumption have also indelibly linked Europe, Africa, and the Americas. The Atlantic biosphere creates a widely connected space with implications for regional and global environmental pressures and challenges, as well as for geopolitical conceptions of the pan-Atlantic.

In this paper, we offer a novel examination of the Atlantic-specific dynamics of selected global environmental challenges and consider whether the interconnected Atlantic Space helps to resolve, or instead worsens, these, asking:

- To what extent do global environmental challenges have particular manifestations in the Atlantic?
- Do these dynamics serve to aggravate problems or promote common solutions?
- How can biophysical and human linkages intersect in environmental governance?
- What are the significant interactions both inside and outside of the Atlantic Space?

We examine Atlantic-relevant aspects of global environmental challenges and a selection of regionally-driven governance solutions, rather than an in-depth examination of drivers, with a look to human consequences and transboundary aspects. It is beyond the scope of this paper to offer a comprehensive survey of environmental challenges or of institutions addressing them. Instead, stories and snapshots illustrate natural and corresponding human links throughout the Atlantic Space and their significance for addressing key environmental challenges.

Challenges are identified using an Earth systems[1] approach. We consider these large-scale challenges in conjunction with other "megatrends," such as population growth, urbanization, and globalization. Particular attention is paid to cross-cutting challenges, such as climate change, which in turn exacerbates other challenges such as food security, maintenance of freshwater supplies, and preservation of ecosystem services.

2. The Atlantic as a Geographic Space

While environmental policy has at times offered an alternative, or contrast, to the state-centric, post-Westphalian perspective of international relations, relatively few spatial constructs successfully transcended nation-state boundaries (Kraemer 2012; Kraemer 2009). The "discrepancy between ecoregional and political boundaries has remained

[1] The United Nations Environment Programme defines the Earth System as "a single, self-regulating system comprised of physical, chemical, biological and human components" and presents major global environmental challenges according to the themes of atmosphere, land, water, biodiversity, and chemicals and waste (UNEP 2012, xviii). The selection of environmental challenges additionally draws upon environmental themes and cross-sectoral issues identified in the 2012 Rio+20 Conference outcome document (UNGA 2012).

one of the greatest challenges in international environmental governance" (Balsiger and VanDeveer 2002).

Theories of "new" environmental regionalism consider spatial regions defined by natural boundaries—e.g., ecoregions—and concepts of the "region" shaped by economic, political, and cultural factors (Balsiger and VanDeveer 2002). The concept of shaping environmental governance to better correspond to ecosystem-based boundaries—such as seas, river basins, or mountain ranges—has been around for some time, though a more recent movement of initiatives to do so has been termed "new environmental regionalism" (Balsiger and Debarbieux 2011). This "new regionalism" may differentiate between "physical" and "functional" regions, offering environmental, as well as cultural or economic aspects (Balsiger and VanDeveer 2002).

Existing scientific literature offers little exploration of the Atlantic as a geographic space. The domains of political and natural science offer distinct conceptions of the Atlantic, but rarely are these bridged. Recent interest in the geopolitical Atlantic has led to a swell in regionally-focused academic output, including on environment and resource topics (see e.g., Isbell 2012; Guinen 2012; Holthus 2012, Isbell 2014). However, while making valuable contributions to regional studies, these approaches have been largely sectoral in nature.

Here, we offer reflections upon and a fresh consideration of ecoregionalism and the Atlantic Space, premised upon its natural, biophysical links, and connected to the cultural, economic, and political flows which influence both environmental challenges and solutions.

3. The Pan-Atlantic Biosphere

Atmospheric and climatic patterns, shared fish stocks and migratory species, transboundary air and water movement, freshwater resources and river basins, and shared commons—atmospheric, high seas, and deep seabed—all connect the Atlantic region at a biological level.

The Atlantic Ocean's eastern and western boundaries are largely defined by continental land masses, except where separated from the Caribbean Sea and Gulf of Mexico by troughs and trenches (Levin and Gooday 2003). Geophysical boundaries are less distinct in the north, where the Atlantic connects to the Arctic Ocean and in the south, where the Atlantic meets the circumpolar Southern Ocean. Here we consider the semi-enclosed seas of the Mediterranean and Baltic Seas as parts of the Atlantic Basin.

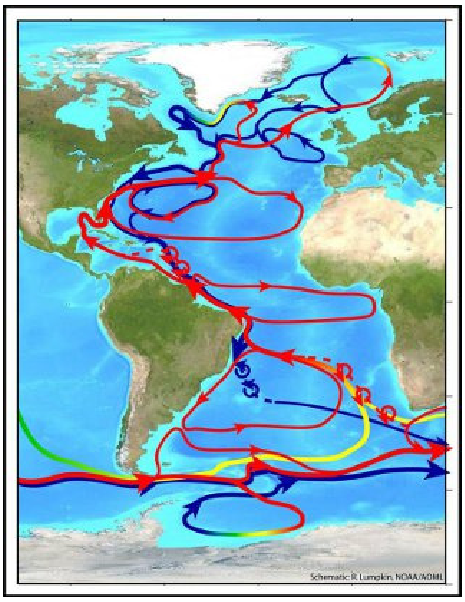
Atlantic marine waters exhibit distinctive properties: Near-shore marine waters are highly diverse, resulting from the continuous north-south bio-geographic gradients from the Arctic to nearly the sub-Antarctic (Holthus 2012). Deep water masses in the Atlantic are more oxygenated and have greater calcium compensation depth than in either the Pacific or Indian Ocean, which in turn affects the distribution of sediment types (Levin and Gooday 2003). The processes in the upper water column that drive primary production in the Atlantic are also distinctive, having, for instance, spring blooms that are more intense and widespread in the North Atlantic than anywhere else in the world.

The Atlantic Ocean's high-productivity areas include an area extending across the North Atlantic, parts of Africa's west coast, the mouth of the Amazon River, the coast of Argentina below the Rio de la Plata, and a narrow area stretching from southern

Patagonia to the Cape of Good Hope (Holthus 2012). Historical major fish catch areas have been in the northeast waters between Europe and Greenland, the offshore banks of the northwest Atlantic, and portions of upwelling areas of western Africa (Ibid.).

The large-scale hydrography of the Atlantic Ocean is dominated by the northward movement of warm surface and intermediate water through the South Atlantic and into the north, where it becomes more saline through evaporation and, after cooling, sinks by vertical convection (Levin and Gooday 2003). Newly formed deep water in the North Atlantic mixes with bottom water and flows southward, along the eastern margin of the Americas, across the equator, into the Southern Ocean and eventually back into the Indian and Pacific Oceans. This "thermohaline conveyor belt," or Atlantic meridional overturning circulation (AMOC), also referred to as the Gulf Stream system, transports large amounts of heat northward in the Atlantic, providing a critical net transfer of heat from the south to north. The AMOC produces cyclical variations in sea surface temperatures in the North Atlantic, affecting atmospheric circulation and causing climatic variations over northern Europe (Ward 2003).

Figure 1. AMOC schematic, with red indicating surface flows, yellow and green indicating intermediate flows, and blue and purple indicating deep flows (NOAA 2012).



A large portion of climate variability in the Atlantic is associated with the North Atlantic Oscillation (NAO), a hemispheric meridional oscillation resulting from the differences in sea-level atmospheric pressure zones between the Azores and the Icelandic region (Hurrell et al. 2001). The NAO influences oceanic circulation and temperatures, wind patterns, weather, and climate in the Atlantic. Winter and spring temperatures in Europe are mainly determined by the NAO, but its influence over winter climates extends from Florida to Greenland, from northwestern Africa over Europe, and even into northern Asia (Ibid; Hüppop and Hüppop 2003). The NAO also affects lake temperatures, water levels, ice phenology, river runoff, and biological systems such as fisheries, and has been shown to affect birds' spring migration patterns.

Most of the water within the Arctic Ocean originates from the Atlantic (AMAP 1998). Cold surface waters in the Arctic are divided into a polar mixed layer with low salinity and a water column of increasing temperature and rising salinity, which differs for both incoming Pacific and Atlantic waters. This vertical salinity gradient helps insulate the upper layers from warmer Atlantic waters and influences sea ice cover (Riedel 2013).

The watersheds of the Atlantic Basin are not separate systems, but drain to the Atlantic Ocean. Atlantic freshwater systems are dominated by large river systems, such as the Amazon, and the geographical features which define watersheds provide natural boundaries for the basin as well.

The Amazon and Congo River Basins are the figurative lungs of the Atlantic. Forests provide regional benefits such as climate regulation, cooling through evapotranspiration, and buffering of climate variability (Megevand 2013). Evaporation and condensation over the Amazon drives global atmospheric circulation, having downstream effects on precipitation across South America and the Northern Hemisphere (Malhi 2008). Congo Basin forests also regulate hydrological cycles and regional climate conditions (Megevand 2013).

Intra-basin migrations of species create further natural links within and throughout the Atlantic space. For instance,

- Southern right whales' long-range migrations cover between Gough Island and South Africa, and between Argentina and Tristan da Cunha, southern Brazil, and South Georgia (Best et al. 1993).

- Atlantic bluefin tuna are highly migratory and cover the pelagic ecosystem of the entire North Atlantic with complex migratory patterns from the northern Atlantic—eastern and western—to the Mediterranean (Galuardi and Lutcavage 2012). The Atlantic bluefin tuna has the widest geographical distribution of any tuna species and is the only large pelagic fish living permanently in temperate Atlantic waters (Fromentin and Powers 2005).

- Leatherback turtles also travel extensively throughout the Atlantic; for example, traveling from the Caribbean to West Africa, South America, Cape Cod, Nova Scotia, and to northern waters between the Azores and the United Kingdom (U.K.).

- Extraordinarily, the European eel has a long-distance, and largely mysterious, migration from freshwater and coastal habitats on the coasts of Europe to spawning grounds in the Sargasso Sea, the only place in the world where the European eel, as well as the catadromous American eel, spawn (Durif et al. 2012; van Ginnekan et al. 2005; Freestone 2012).

Anthropogenic resource use and exchange of plant and seed materials has also created additional natural and cultural links throughout the Atlantic:

- New World explorers opened up avenues for trade and exchange—for example, reinventing the African food supply by introducing new species such as cassava, beans, potatoes, and maize (McCann 2001).

- At least a thousand years before Europeans arrived in the New World to further spread maize, it was passed from the Tamaulipas region of Mexico to places as remote as Massachusetts and Paraguay (Dean 1987).

- Rubber was also discovered by New World explorers and became widely sought after in the 1800s (Ibid.) The rubber trade became a fixture of the Brazilian economy, providing almost 40 percent of export revenues before cultivation later moved to Southeast Asia, decreasing economic growth for Brazil.

- Potatoes, originating in the Andes, were widely adopted in Europe in the seventeenth and eighteenth centuries and later spread to the rest of the Old

World via European sailors and missionaries and became indirectly responsible for notable increases in population size (Nunn and Qian 2011).

- Sugar cane, though native to South Asia, was brought from the Mediterranean and Atlantic islands to Brazil and the Caribbean, providing food to northern states and linking the Atlantic Basin further via African slave labor and plantation colonies (Dean 1987).
- Honeybees and earthworms were inadvertently imported from Europe to North America by colonial setters, unleashing enormous changes to the continent's native forests, meadows, and orchards (Mann 2007).

4. From Ubiquitous Problems to Shared Solutions?

In today's globalized world, many environmental challenges, such as transboundary pollution, deforestation, and climate change, increasingly involve non-local impacts and actors. The cumulative effects of anthropogenic pressures on the natural environment can no longer be confined to the local, but are now are regional, and even global, in nature. Intensifying human activities such as burning fossil fuels, extensive deforestation and land use change, and waste production create environmental pressures and drive regional and global change.

4.1. Climate Change and Atmosphere

Climate change may be considered to be the paramount global environmental challenge of our time. Atmospheric concentrations of carbon dioxide (CO_2), methane, and nitrous oxide have increased to unprecedented levels, with CO_2 concentrations having grown by 40 percent since pre-industrial times and continuing to rise (IPCC 2013). This dramatic increase in atmospheric greenhouse gases heralds major consequences and costs for both natural and human systems.

4.1.1. Impacts of Climate Change

All parts of the world will experience impacts due to climate change, but certain common patterns and vulnerabilities can be seen within the Atlantic Basin (see Stefes et al. 2014). Across the Atlantic, climate change will cause widespread rising sea levels, coastal flooding, saltwater inundation, temperature and precipitation changes, and more, threatening human well-being and regional development.

- In Atlantic coastal areas, sea level rise will cause flooding, coastal erosion, and saltwater intrusion into groundwater supplies, impacting major cities such as Miami, New York, and New Orleans, which are some of the most vulnerable in the world to sea level rise (Hallegatte et al. 2013). A surge in sea levels on the U.S. east coast was already documented and connected to a slowing of the AMOC between 2009 and 2010 (Kenigson and Han 2014).
- In Europe, high costs from sea level rise and coastal flooding are projected for countries such as Belgium, Denmark, Germany, the Netherlands, France, Spain, Italy, and the U.K (EEA 2012).
- Small island countries in the Caribbean and Central American are considered to

be particularly vulnerable as well, given high exposure to weather events, large coastal populations, and low coastal elevation (Magrin et al. 2014).

- More than three quarters of the populations of coastal states in Latin America and the Caribbean live within 200 kilometers of the coast (Ibid.).

- In Western Africa, some projections show that 10 to 15 percent of countries' populations may be acutely vulnerable to flooding events in countries such as Benin and Nigeria, which have large coastal settlements in hazardous areas (UNEP 2012). The West Africa coast is densely populated, particularly stretching from Accra to Lagos, and will be hit by flooding and crop loss due to increased precipitation, sea level rise, and storm surges (USAID 2013).

Precipitation and temperature changes stemming from climate change threaten Atlantic Basin food security, as discussed further below. Precipitation and temperature variability and new extreme weather and drought events are predicted to generally undermine large-scale industrial agriculture, as seen in North America and Europe, as well as small-scale subsistence farming, more commonly found in Africa and Latin America (Stefes et al. 2014). In South and Central America, rainfall changes will vary geographically, with projections showing an increase in dry spells east of the Andes, and in warmer temperatures in most of South America (Magrin et al. 2014). Precipitation decreases are expected across southern Europe, while precipitation increasing in the North (EEA 2012).

Human health in the Atlantic Basin is expected to be directly affected by rising climatic disasters such as extreme heat waves, floods, landslides, and storms. Additionally, rising temperatures and changes in precipitation are expected to encourage the spread of disease, particularly vector-bone disease such as malaria, dengue, cholera, Lyme disease, and West Nile Virus. Extreme heat will also increase vulnerability to heat-related deaths and conditions such as heart attacks (Stefes et al. 2014).

At the far northern end of the Basin, September sea ice extent in the Arctic has been declining rapidly, reaching a record low in 2012 of 3.41 million square kilometers, 44 percent below the 1981-2010 average and 16 percent below the previous record from 2007 (NSDIC 2015). Diminishing ice cover presents the possibility of further opening towards the Atlantic and of new economic activities, which may present their own environmental challenges. Hydrocarbon exploration and development, shipping, and increased fisheries activity, along with extreme alterations to ice ecosystems and the marine food web, are likely to occur. Freshening of surface layers could lead to changes in the delivery and cycling of nutrients, increasing primary production and in turn, leading to an increase in certain fish species, like cod, which support other species in the marine food web, like harbor seals; others, like harp seals, suffer as they lose important ice habitat and prey species move to cooler waters (AMAP 2011).

There has been concern that significant freshening from increased ice sheet melt in Greenland could impact the AMOC and cause associated surface cooling in the North Atlantic (IPCC 2013). Recent observations have shown this to in fact be occurring, with the AMOC weakening over the past hundred years, particularly in recent decades (Rahmstorf et al. 2015). The impacts could include cooling temperatures in Europe and increased sea levels in the eastern United States (U.S.), as well as disruptions to fisheries and marine ecosystems.

New research also suggests that the Atlantic Ocean may be playing a role in absorbing heat, with deep waters serving as a "sink," and thereby delaying rising temperatures due to climate change (Chen and Tung 2014). Warming water penetrates most deeply in the North Atlantic and Southern Ocean (Church et al. 2013). The AMOC transports warm water from the Caribbean to the North Atlantic, where it becomes colder and more saline and sinks, flowing southward again. On the other hand, some researchers argue that processes in the Pacific Ocean drive changes in the North Atlantic current (Lee 2014).

4.1.2. Response to Climate Change: Mitigation

The Atlantic is home to some of the most vulnerable climate victims and also some of the worst climate offenders. Given the global nature of climate change, the need for international cooperation is paramount. While there are local aspects to mitigating change, climate change is ultimately exogenously driven, with wide-ranging effects that may be sooner recognized in some countries than others. In other words, the problem of climate change cannot be dealt with independently by Atlantic states. Nonetheless, opportunities for regional collaboration are present on both mitigation and adaptation fronts.

Global governance architectures are fragmented in general and this fragmentation is particularly pronounced within the area of climate change (Biermann et al. 2014). The varying range of climate capacities and impacts leave room for diverging scenarios and different policy responses (Stefes et al. 2014). This holds true in the Atlantic Basin, where climate change commitments, policies, and multilateral cooperation are mixed between regional actors (Mehling 2013):

- The European Union (EU) has been a climate leader, passing a broad range of policies to reduce emissions and maintaining relatively consistent reductions. Robust EU climate policy includes the world's oldest and largest emissions trading system—the EU Emissions Trading System (ETS)—and a set of integrated climate and energy policies to reduce greenhouse gas emissions, increase renewable energy generation, and increase energy savings.

- The U.S. has failed to adopt major climate legislation, but new executive level and state action promise progress even as action from the U.S. Congress appears ever unlikely. In 2014, the U.S. Environmental Protection Agency proposed new rules for reducing carbon emissions from power plants and the U.S. struck a bilateral agreement with China to reduce emissions by 2030, injecting new hope into global climate change negotiations.

- Canada committed to a 17 percent reduction in greenhouse gas emissions by 2020, but then withdrew from the Kyoto Protocol in 2011 and current emissions are projected to rise, largely due to oil sands production.

- Brazil has made progress in reducing deforestation in recent years and has enacted national climate change legislation. Deforestation rates in Brazil have recently begun to slow. At the same time, plans for emissions trading systems have been put on hold and the Brazilian government opened up energy auctions to coal-fired plants again, due to higher energy demand and lower hydroelectric production from below-normal rains (Karstensen et al. 2013).

- Mexico instituted a General Law on Climate change in 2012, aiming to cut emissions in half by 2050, and has enacted a carbon tax.

- South Africa, which depends heavily on coal for electricity generation, has set renewable energy targets, replacing its feed-in-tariff with the Renewable Energy Independent Power Producer Programme in 2012.

- Unlike greenhouse gas emissions, which have a planetary climate impact, short-lived climate pollutants (SLCPs)—such as black carbon, methane, tropospheric ozone, and hydroflurocarbons—affect regional climate systems and reductions in SLCPs have regional health and food security benefits. SLCPs are the subject of mitigation efforts from a number of Atlantic countries, with leadership from the U.S. and Sweden in establishing the Climate and Clean Air Coalition.

The future of global climate policy and the United Nations Framework Convention on Climate Change (UNFCCC) remains in flux in the lead up to COP 21 in Paris in 2015. Further fragmented efforts at the regional, national, and sub-national levels continue to progress, albeit slowly, as well as other forms of multilateral and transnational cooperation in the Atlantic and globally. Regional emissions trading systems offer examples of intra-regional cooperation to link emissions reductions, even daring to hint at a distant vision of a transatlantic carbon market. As of 2014, around 40 countries and 20 sub-national jurisdictions had put a price on carbon through either emissions trading systems or a carbon tax (World Bank 2014).

4.1.3. Response to Climate Change: Innovation and the Price of Carbon

In the Atlantic Basin, these emissions trading systems include the ETS, the U.S. Regional Greenhouse Gas Initiative, and Alberta's Greenhouse Gas Reduction Program. In 2014, California and Québec formally linked their carbon markets, demonstrating that integration is possible; on the other hand, plans to link the EU ETS with Australia fell through in 2014, demonstrating the complexity of linking markets and placating domestic demands. California and Québec, along with British Columbia, are the only remaining partners of the Western Climate Initiative, which once had up to 23 partners and observers from U.S. states, Canadian provinces, and Mexican states.

There has been additional interest in emissions trading from Brazil, which has considered an emissions trading program but stalled and has also considered a carbon tax, South Africa, which is considering a hybrid approach, Costa Rica, and Mexico. Mexico has already implemented a carbon tax, alongside British Columbia and in Europe, Denmark, Finland, France, Iceland, Ireland, Norway, Switzerland, and the U.K. (World Bank 2014).

From a mitigation standpoint, renewable energy cooperation, with shared technology, finance, and policy development, can help to maximize regional expertise and resources. International cooperation on carbon pricing instruments offers opportunities for South-South and South-North dialogues and bottom-up efforts at the regional, national, or sub-national level can move progress forward on emissions reductions and support eventual linkages and the possibility of a comprehensive global carbon market. In the Atlantic, transfers of wealth and technology from the more developed North to the more vulnerable South can help to meet these needs.

Nearly a quarter of anthropogenic greenhouse gas emissions come from agriculture, forestry, and land use—about half of which comes from deforestation and forest degradation and the remaining half from agriculture, including livestock farming (Bastos Lima et al. 2014). In Latin America and Central Africa, as well as Southeast Asia, these activities constitute the largest source of emissions. Land use and forestry emissions are, also, however, connected to external actors through global supply chains, as demand for commodities, such as soybeans and beef, create land use pressures.

Mechanisms to reduce land use, forestry, and agriculture emissions and protecting carbon sinks have been explored through global climate policies, such as through the Kyoto Protocol's Clean Development Mechanism (CDM) and Joint Implementation (JI), various offset mechanisms, and through REDD+ (Reducing Emissions from

Deforestation and Forest Degradation). Today, it remains unclear how land use and forestry emissions will be taken into account in the post-2015 climate regime. As of 2013, Norway was the largest contributor of REDD+ finance, followed by Australia, the U.K., and the U.S. (Caravani et al. 2013). The majority of climate finance for REDD+ funding has targeted Latin America and the Caribbean, with most of this going towards Brazil (Ibid.). In Sub-Saharan Africa, the largest recipient has been the Democratic Republic of Congo. At the end of 2014, Peru, Germany, and Norway entered into a partnership to support Peru's efforts in reducing emissions from deforestation and forest degradation in the Peruvian Amazon.

Within climate change debates, the principle of common but differentiated responsibilities has featured prominently and is closely linked to historic North-South divides. In the Atlantic, the North has historically held responsibility for a greater share of global emissions and hence greater responsibility for the climate problem, while the South's emissions have trailed significantly. However, as in the rest of the world, this dynamic is shifting as southern countries' economic positions rise and so do their emissions. Between 1990 and 2013, emissions in the North also continued to rise—throughout the EU, in the U.S., and in Canada. However, developing countries have made large percentage jumps over the past two decades, now often on par with the North, although per capita emissions vary more considerably.

In the spirit of common and but differentiated responsibilities, countries in the North have also undertaken certain responsibility for financial assistance to developing countries. While not a substitute for North-South contributions, there has also been a rise in South-South cooperation in climate change, including renewable technology development and bilateral agreements (UNDP 2013). In 2012, North-South development bank investments in clean energy equaled $10 billion, compared to a record $7.5 billion in South-South flows (BNEF 2013). The UN's Green Climate Fund has seen both developed (e.g., Germany, U.S.) and developing (e.g., Mexico, Panama) countries making contributions (Nicola and Morales 2014). In 2014, climate finance was split almost equally between OECD and non-OECD countries, with flows from developed to developing countries falling—though some of this may be attributed to falling costs for renewable energy technologies—and most funds remaining in their countries of origin (Bucher et al. 2014).

4.1.4. Response to Climate Change: Adaptation

Successful adaptation to climate change is enabled by collective action and by effective governance mechanisms and institutions (Adger et al. 2003). The large diversities within the Basin—environmentally, geographically, and politically—give rise to a wide range of impacts and response capacities. Climate change vulnerabilities within Atlantic Basin countries are varied, though some commonalities exist across the Atlantic (Stefes et al. 2014; Martinez et al. 2014); yet in many cases, environmental characteristics and climate impacts are in fact shared with areas outside of the Atlantic Basin.

Stefes et al. (2014) found examples of transnational cooperation on climate change adaptation between North and South Atlantic actors, largely focusing on research and capacity building in vulnerable communities. Shared histories, cultures, and language, which are unique to the Atlantic, serve as drivers of bilateral and multilateral cooperation. While cooperation is present, climate change could nonetheless alternatively instigate regional tension and conflict from resource scarcity or forced migration (Heisbourg 2012).

4.1.5. Response to Climate Change: Energy Transformation

Driving global climate change is the unabated use of fossil fuel energy, supporting production and consumption patterns that may be considered the “Atlantic Lifestyle.” Energy intensive lifestyles driven by high carbon fossil fuels originated in the Northern Atlantic and are now spreading to developing and middle-income countries with rising populations. Energy demand has historically been higher in the Northern Atlantic, but is now growing rapidly in the Southern Atlantic and by 2035 may account for as much as 20 percent of global energy demand and half of Atlantic Basin demand (Isbell 2012).

Still, there remain vast discrepancies between energy producers and consumers in the Atlantic. Over 1.3 billion people worldwide are without access to energy, including nearly 70 percent of inhabitants in Sub-Saharan Africa, a figure which may grow to almost 700 million people by 2030, surpassing Asia’s unelectrified population (IEA 2012; Lighting Africa 2013). Energy poverty has considerable implications for the environment, health, development, gender equality, and education. Sub-Saharan Africa has experienced rapid growth in solar off-grid lighting solutions, with sales growth now exceeding 100 percent annually, although high reliance on traditional biomass and kerosene for heating, cooking, and lighting purposes remains (Lighting Africa 2013).

The Atlantic Basin’s abundant and dominant fossil energy systems and trade is responsible for a large share of global petroleum and gas production—about one third of global petroleum, gas, and liquefied natural gas (LNG) production—and the Basin holds significant fossil fuel reserves: 40 percent of the world’s petroleum, 12 percent of gas reserves, and nearly 60 percent of technically recoverable shale gas reserves (Isbell 2012).

Advances in energy technologies, enabling access to unconventional oil and gas reserves, have dramatically altered energy markets and benefited Atlantic producers. The shale revolution in the U.S. has raised it to the world’s leading fossil fuel producer. Ultra-deep offshore, pre-salt discoveries in Brazil promise production increases, though the realization of these hinges on a number of factors, including world oil prices. Isbell (2014) finds that the last decade has seen the development of a “Southern Atlantic oil ring” through investment in offshore oil exploration and production which continues to rise throughout the Atlantic Basin. Notably the shale gas boom has had an impact on the energy mix of the Atlantic Basin, increasing supply, putting downward pressure on natural gas prices, and displacing coal and hence lowering emissions as a result of fuel switching.

While rich in fossil fuels, the Atlantic also holds great renewable energy potential and promise for propelling energy transformations and decarbonization. The region holds around 70 percent of global installed renewable energy capacity and is experiencing rapid growth in solar, bioenergy, and wind. The Southern Atlantic in particular possesses excellent renewable resources, with high solar, biofuels, and hydropower potential. Improved policy and regulatory coordination within the Basin can help meet growing energy needs, increase access to energy, facilitate transformations to low-carbon sources, and reduce additional environmental externalities from uncoordinated policies.

Atlantic actors have helped drive the expansion of renewable energy technologies. Germany in particular has been a leader in installed solar capacity over the last decade and leading exporter of solar technologies. Solar and wind technologies are now global industries, though have roots in Atlantic Basin countries—e.g., the U.S. and Germany for solar, and the U.S., Denmark, and Germany for wind.

Government policies have helped spur renewable energy growth throughout the Basin Atlantic. For example, feed-in-tariffs have helped drive renewable energy growth in Germany and Spain, while the U.S. has largely relied on a mix of state and federal tax credits, subsidies and rebates, and renewable portfolio standards (IEA 2012). The U.S.

Public Utilities Regulatory Policy Act of 1978 (PURPA) is the world's first "type" of feed-in-tariff policy, while the modern German feed-in-tariff is the first of its kind and has influenced the spread of similar policies throughout the world (Gallagher 2014; Motl 2011).

The U.S. and Brazil are leading ethanol producers and trade significant volumes of biofuels, while Europe and the U.S. are the largest biodiesel producers, although rising biofuel consumption has led to adverse environmental outcomes, as described further below. Brazil is also an exporter of biofuels technologies to Africa.

Hydropower provides around 60 percent of electricity in Sub-Saharan Africa—minus South Africa—and has also been a strong focus for countries like Brazil and Norway (Behrens 2011). Hydropower has been a major component of the energy mix of Latin America and the Caribbean, though in light of proposed-mega dam projects, particularly in Brazil and Chile, indigenous and environmental groups have voiced protests (Kammen et al. 2014). Offshore wind, wave, and tidal energy developments are currently dominated by Europe and North America.

4.1.6. Energy-related Pollution

The challenges created by fossil fuel energy production and use are not limited to the greenhouse effect. Fossil fuel energy sources create operational waste, including hazardous material, water discharges, intensive water use, disturbances to biodiversity, and local and regional air pollution.

The burning of fossil fuels is a major source of air pollution, emitting particulate matter, nitrogen oxide, CO_2, and methane, and causing major health problems. An estimated seven million people die prematurely each year due to air pollution (WHO 2014). Intercontinental transport of particulate matter (PM) alone contributes to exceedences of local air quality targets and is responsible for 380,000 premature deaths worldwide (UNEP 2012). While in PM emissions have been significantly reduced in Europe and North America, PM remains a major pollutant in some cities in Latin America and Asia, and also Africa, where reducing and monitoring emissions are continued problems.

In North America and Europe, transboundary air pollution was shown to cause dimming in the Northern Atlantic and to shift rainfall southwards (Ramanathan and Feng 2009). Reductions in aerosol forcing over the North Atlantic have also likely contributed to an increase in tropical cyclone activity since the 1970s (IPCC 2013). In the Southern Atlantic, dust transport from Africa to South America, as well as the Caribbean and North America, is an important source of air pollution that is also expected to increase with climate change (Prospero 2014).

Transatlantic ground-level ozone transport from North America has been proven to contribute to European pollution levels, and to be strongly correlated with the NAO (Li et al. 2002). The influence of the NAO on intercontinental pollution transport from North America to Europe and from Europe to the Arctic is predicated to grow stronger under climate change scenarios (Christoudias et al. 2012).

Northern Atlantic countries have historically emitted more air pollutants than their southern counterparts, but have also successfully established cooperative arrangements for reducing them. The 1979 Convention on Long- Range Transboundary Air Pollution (LRTAP) is arguably the world's most significant legal regime for transboundary air pollution. LRTAP and its protocols, which set targets for a variety of air pollutants, have reduced regional air pollution and cover most countries in the Northern Hemisphere, within and outside of the Atlantic Basin. Overall, sulphur dioxide and surface ozone pollution in North America and Europe have reduced over the past two decades, likely in response to the LRTAP and targets in the U.S., EU, and Canada (UNEP 2012).

4.2 Water and Water-born Resources (fish)

Europe, Africa, and the Americas are bound together by the Atlantic Ocean, a crucial source of ecosystem services (e.g., coastal protection, water purification), dietary protein, economic activity (e.g., fisheries, tourism, recreation), and spiritual and cultural value. Levels of dependence on marine and coastal goods and services vary between countries and regions, but on the whole, Atlantic coastal populations receive significant direct and indirect benefits from marine resources (Tedsen et al. 2014).

Yet Atlantic marine and coastal ecosystems, like others around the world, face myriad threats, such as marine pollution—including debris, persistent organic pollutants, heavy metals, nitrogen compounds, oil spills and leaks, exploitation of migratory fish stocks, and the spread of invasive species. Atlantic freshwater systems, too, face threats from anthropogenic pollution and challenges in meeting competing demands.

4.2.1. Fisheries

Overfishing threatens not only biodiversity and ocean habitats, but also human food supplies. The Atlantic was the first of the world's oceans to be overfished and today stocks in most major fishing areas in the Atlantic are overexploited (UNEP 2006; Holthus et al. 2012). In the early 1990s, North America's formerly abundant Grand Banks fisheries, one of the richest in the world, experienced a severe collapse. The collapse of the Northern cod fishery, which had devastating economic impacts for local economies, was the result of a number of factors, such as overfishing, the introduction of industrialized trawlers and other new technologies following World War II, poor management decisions and insufficient enforcement, and flawed understanding of marine ecosystems and stock assessments (Milich 1999).

Illegal catch from other Atlantic countries, especially from Europe (e.g., Portugal, Spain), contributed to the depletion and caused friction with Canada, resulting in controversial enforcement actions by Canada against Atlantic fishing vessels, Spain's claim against Canada in the International Court of Justice, and the threat of EU sanctions (see Tedsen et al. 2014). Canada and the EU ultimately reached an agreement limiting but not excluding the EU from fishing in the Grand Banks, and Canada and the U.S. reached a bilateral agreement to address stock declines in the 1990s. Today, illegal, unreported, and unregulated (IUU) fishing in the northern Atlantic is more strongly constrained, though continues nevertheless and stocks have still been unable to recover, despite limitations.

Canada earlier attempted to address the issue of Grand Banks straddling stock management through the establishment of the Northwest Atlantic Fisheries Organisation (NAFO) in 1979[2] and though cooperation with the EU, a chief NAFO member, broke down between 1985 and 1992 after EU harvests exceeded quotas (Bjørndal and Munro 2002). Regional Fishery Bodies (RFBs) aim to conserve, manage, and develop fisheries, with mandates ranging from advisory to legally binding and RFBs with management mandates, like NAFO, are called Regional Fisheries Management Organizations (RFMOs). There are currently fourteen RFBs overseeing

[2] NAFO was preceded by the International Commission for the Northwest Atlantic (ICNAF), one of the world's first regional fisheries bodies.

boundary-straddling, highly migratory, or high-seas migrating fish stocks in the Atlantic, like the Atlantic bluefin tuna (Holthus et al. 2012).

Atlantic tunas are historically some of the most heavily fished stocks on the planet, though were still plentiful when the International Commission for the Conservation of Atlantic Tunas (ICCAT) first convened in 1969. Catch quotas, which were eventually implemented as stocks plummeted, were challenged by countries including Spain, France, Japan, and the U.S.— wishing to retain historically dominant fleets and resisting new entrants—, as well as Brazil, Morocco, Côte d'Ivoire, and Senegal—developing countries pushing back against restrictions on fleet growth (Webster 2009).

In the Southern Atlantic, port control remains more limited and illegal fishing higher. Developing countries are in fact at greater risk from illegal fishing, and are often more dependent on fisheries as sources of animal protein and for livelihoods. In West Africa, for instance, total estimated catches were estimated as 40 percent higher than reported catches, signaling severe exploitation of the marine ecosystem (Agnew et al. 2009). Illegal and unreported catches were found to be highest in the Eastern Central Atlantic—stretching from Morocco down to Angola—where there has been a steady increase in illegal fishing, along with the Southwest Atlantic, and lowest in the Southwest Pacific.

4.2.2. Protection of the Marine Environment

Other relevant mechanisms for regional oceans governance include various regional conventions, Regional Seas Programmes—largely supported by the United Nations Environment Programme (UNEP), Large Marine Ecosystem (LME) mechanisms, and a movement towards establishing networked or high seas marine protected areas (MPAs).

UNEP's Regional Seas Programme aims to address ocean degradation and sustainable management and includes wide international participation and thirteen programs, including in the Wider Caribbean, Mediterranean, and Western Africa, most of which are accompanied by legally-binding regional seas conventions (e.g., Cartagena Convention for the Caribbean and the Barcelona Convention for the Mediterranean) (UNEP 2015).

LMEs encompass relatively large areas with distinct environmental properties which can be used to evaluated ecosystem-based management measures at a regional level (Sherman 1994). In West Africa, for example, the Guinea Current Live Marine Ecosystem—a project including 16 countries and covering an area spanning from Guinea-Bissau to Angola—and the Canary Current Large Marine Ecosystem—including participation from seven countries and extending from Guinea-Bissau north to Morocco—encourage regional collaboration and transboundary management.

Regional MPA[3] networks are being developed or under consideration in the Atlantic through mechanisms including the Cartagena Convention, the OSPAR Convention, the EU's Natura 2000 Programme, and the Regional Network of Marine Protected Areas in West Africa (RAMPAO) program (UNEP-WCMC 2008). The OSPAR Commission in

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[3] MPAs have been defined as "a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (IUCN 2012). Linking individual MPAs, including between countries and across regions, can help further reduce impacts, provide sufficient area and habitat for marine species, provide spatial links needed to maintain ecosystem processes and connectivity, and improve resilience (Laffoley et al. 2008).

the Northeast Atlantic established the world's first network of MPAs in Areas Beyond National Jurisdiction (ABNJ) in 2010. Management of these MPAs is set out by non-binding OSPAR Recommendations, reflecting limited competence of the OSPAR Commission in managing human activities in ABNJ, and is done in collaboration with the North-East Atlantic Fisheries Commission (NEAFC), which regulates fisheries in the area.

4.2.3. The Atlantic High Seas

As uses of and threats to the ocean environment in ABNJ have grown—e.g., overfishing, pollution, climate change, interest in marine genetic resources, laying submarine cables for internet connections, maritime transport—so have discussions within the international community of how better to conserve and protect these areas, including through the UN General Assembly (UNGA) and various regional organizations, the most advanced of which have taken place within Atlantic regions (Rochette et al. 2014; Freestone 2012).

- In 2009, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) established the South Orkney Islands Southern Shelf MPA as the world's first MPA in ABNJ, located in the Southern Ocean at the far southern portion of the Basin's reach (Rochette et al. 2014).

- The Pelagos Sanctuary for Mediterranean Marine Mammals was established by France, Monaco, and Italy in 1999, and is partly located in ABNJ, where coastal states have not yet established there EEZs (Ibid.).

- In 2014, the Abidijan Convention in Western Africa established a working group to consider MPAs in ABNJ and also signed a memorandum of understanding with the Regional Network of Marine Protected Areas in West Africa (RAMPAO) to cooperate on marine protected area in the region. RAMPAO was formally launched in April 2007 and covers 23 MPAs in Cape Verde, Mauritania, Senegal, the Gambia, Guinea Bissau, and Sierra Leone.

- Perhaps most unique of all, and demonstrating intra-basin cooperation, is the case of the Sargasso Sea—home to the spawning grounds of the European and American eels, unique algae that accumulate in the North Atlantic Subtropical Gyre, the world's only sea without coast, and numerous threatened and endangered species, and which, with the exception of a small portion in the Bermudian EEZ, lies primarily in ABNJ (Freestone 2012). In 2010, the Sargasso Sea Alliance was formed, led by the Government of Bermuda and an international partnership, to secure recognition of the Sargasso Sea's ecological significance and use existing instruments to seek its protection. The Alliance's work resulted in the Sargasso Sea Commission, established in 2014 by the Azores, Bermuda, Monaco, the U.K., and U.S., joined by representatives from the Bahamas, British Virgin Islands, the Netherlands, South Africa, Sweden, Turks and Caicos, and from the OSPAR Commission, International Seabed Authority, the Inter-American Convention for the Conservation of Atlantic Sea Turtles, the Convention on Migratory Species, and the International Union for Conservation of Nature (IUCN) (Freestone and Morrison 2014). The Commission operates under a non-binding declaration and as a standalone legal entity established under Bermudian law.

4.2.4. Sea-Bed Mining

Rising demand for minerals and metals alongside technological developments are also driving new interest in ABNJ and in deep seabed mining. While not yet a large-scale environmental challenge or commercial scale activity, seabed mining is an emerging oceans use that threatens widespread impacts to marine biodiversity and impacts (Allsopp et al. 2013). Most sea-bed mining activity to date has focused on the Pacific Ocean, but there is growing interest in seabed minerals around the Mid-Atlantic Ridge.

The International Seabed Authority (ISA)[4] has granted two exploratory contracts for exploration for polymetallic sulphides along the mid-Atlantic Ridge south of the Azores to the Institute français de recherche pour l'exploitation de la mer, sponsored by France, and to the Government of the Russian Federation. In July 2014, Companhia de Pesquisa de Recursos Minerais, a Brazilian entity, was granted an application for exploration for cobalt-rich ferromanganese crusts in the Rio Grande Rise in the South Atlantic Ocean (ISA 2014a, 2014b). Recently, German scientists discovered large manganese nodule deposits in the Atlantic that, for the first time, are on scale with those in the Pacific (Griggs 2015). There has been additional interest in exploration within territorial waters in Namibia and Brazil.

The growing interest in seabed minerals in the Mid-Atlantic Ridge region has spurred the ISA to begin consideration of an environmental management plan. The regional government of the Azores has initiated a scientific and technical process to explore development of a plan covering the Mid-Atlantic Ridge and cross-jurisdictional areas.

4.2.5. Effects of Climate Change and Pollution on the Marine Environment

Increasingly, climate change is emerging as the leading challenge for marine ecosystems and driver of environmental change. Historically, oceans have sequestered about 30 percent of emitted CO_2, causing acidification, harming calcareous organisms, and impacting the entire food chain (IPCC 2013). More than 75 percent of Atlantic coral reefs are threatened by climate change, as well as by bioprospecting and bottom-trawling (Nellemann et al. 2008). Warming ocean waters are causing shifts in marine species and pole-ward movements of Atlantic species have been observed. Atlantic fisheries are following global trends of moving to deeper waters and to the high seas, as well as from North to South (Ibid; Richardson et al. 2012). Marine species such as phytoplankton, zooplankton, and bony fish, are moving towards the poles at the average rate of 72 kilometers per decade, far faster than the terrestrial average of 6 kilometers per decade (Poloczanska et al. 2013).

Climate change is limiting availability of freshwater resources in both urban and rural areas, following decreased precipitation and river flows, higher temperatures, glacial retreat, and higher average temperatures (Stefes et al. 2014). Glacier melt in the Andean mountain range is identified as a significant threat to watersheds, posing serious availability issues for Atlantic cities and populations in Colombia, Peru, Chile, Venezuela, Ecuador, Argentina, and Bolivia. Summer river flows are expected to decrease over much of Europe, including in regions where overall annual flows are expected to increase, and alpine glacier melt has already caused a 13 percent increase in contributions to summer run-off in glacier-fed rivers (Kovats et al. 2014).

Brazil, which is endowed with twelve percent of the world's freshwater, has already begun to experience dire urban water shortages (Davies 2014). São Paulo's reservoir system is nearly depleted, as Southeast Brazil faces its worst drought in nearly a century, and residents' taps are running dry (Romero 2015). Worsening natural drought conditions are likely magnified by climatic variability, clearance of Amazonian forests

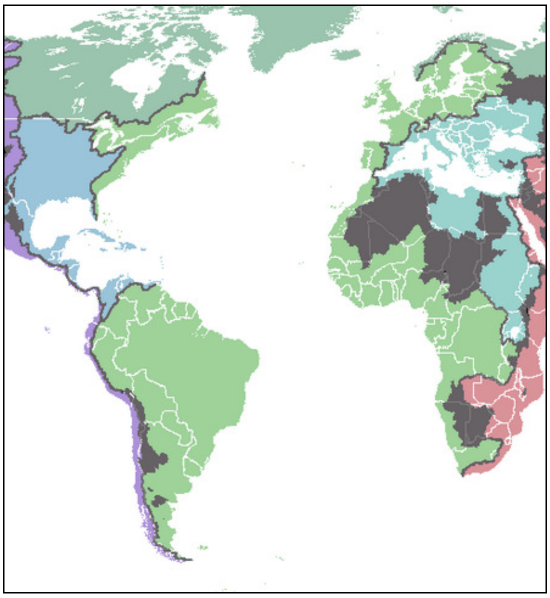
[4] The ISA was established through the United Nations Convention on the Law of the Sea (UNCLOS) to govern the seabed in areas beyond of national jurisdiction, known as "the Area," in which resources are declared to be the common heritage of mankind.

which release moisture southward, polluted rivers, inadequate water infrastructure, and population growth. In Brazil, and other Atlantic countries, climate-related droughts have implications for energy production as well, as lower water levels lead to reduced hydropower output (UNEP 2012). Droughts were responsible for a 13 percent drop in hydropower energy consumption in Brazil in 2013 (Lawrence 2014) and in 2014, hydropower generation similarly dropped due to drought in the western U.S.

4.2.6. Freshwater in the Atlantic Basin

Freshwater activities in the Atlantic Basin are linked to the degradation of marine ecosystems, as pollutants from inland areas degrade regional seas (Biswas 2004). Atlantic Basin freshwater systems are dominated by large river systems, such as the Amazon, which carries 16 percent of global runoff (Uitto and Duda 2002). Rivers and streams deliver freshwater and other nutrients to estuaries and coastal seas, along with pollution from run-off and nonpoint discharges.

Figure 2: Map showing drainage basins for the major oceans and seas (Citynoise 2007).



A significant portion of the world's freshwater resources are shared by multiple countries, entailing cooperation across borders in order to avoid overexploitation and competition. Three out of five of the world's most-highly shared river basins, with between nine and eleven nations, are shared by Atlantic states: the Congo, Rhine, and Niger basins (UNDESA 2014).

The North Atlantic has a rich history of joint management of shared river basins (Kraemer 2009; Kraemer and Kampa 2003). The EU's Water Framework Directive (WFD) aims to ensure good water quality, setting requirements for water management through plans for hydrologically and geographically defined river basins and a revolutionary framework that integrates across borders and sectors (e.g., shipping, fishing, hydropower). In the U.S., shared use of the Potomac River and diplomatic efforts served as a cooperative foundation that supported the nascent republic (Kraemer 2012). Experiences in the North Atlantic, for instance in the Great Lakes and Rhine, have shown successful cooperation over time (Uitto and Duda 2002). In the South Atlantic, co-management institutions has been a slowly evolving process, though in Latin America, transboundary cooperation has been described as generally less acrimonious and more cooperative than experienced other parts of the world (Rogers 2002; Biswas 2013).

4.2.7. Water Supply and Sanitation Services

More than one billion people worldwide lack access to clean drinking water and even more lack adequate sanitation services (Gleick 2003). Access to basic sanitation is poorest in Sub-Saharan Africa, with 330 million people lacking access to proper sanitation (UNEP 2012). One Atlantic-born solution to meet water and sanitation needs has been a push towards water privatization. Water privatization originated in U.S. municipalities in the early 1800s, though much of the U.S. has since turned back towards public ownership models. France, meanwhile, has seen the opposite trend, moving from municipal services to private operators in the 19th century. Today, French multinational corporations hold a dominant position in providing private water services throughout the world, with other major world players from the North including the U.K., U.S., and Germany (Hall and Lobina 2012; Barlow and Clarke 2004).

In South America, public monopolies were widespread until the mid-1990s when governments, such as in Buenos Aires and Mexico City, began seeking private sector management (Gleick 2003). A push during the 1990s to improve water and sanitation in the South through private sector participation, with encouragement by multinational financial institutions and development agencies, is considered controversial and led to clashes over water rights in countries such as Bolivia, Argentina, and South Africa (Coleman 2012; Budds and McGranahan 2003).

4.2.8. Virtual Water: The Hidden Trade in Water

“Virtual water” refers to the idea that when goods and services are exchanged, so is the water used to produce these goods (Allan 1998). The virtual water “trade” can be used to redistribute water from scarcity-prone regions, and has been shown to improve global water use efficiency overall, though such exchanges can likewise increase degradation (Dalin et al. 2012). Between 1986 and 2007, Asia increased its imports by more than 170 percent, switching from North America to South America, particularly Brazil and Argentina, as its primary supplier (Ibid.). This rise is largely associated with increased soy imports, which has led to water savings on a global scale but contributed to deforestation in the Amazon.

In North America, exports to Asia have nonetheless grown, as intra-regional virtual water trade has increased—perhaps in part driven by the North America Free Trade Agreement (NAFTA); meanwhile, exports to Europe have shrunk. In water-scarce California, a large percentage of the state’s water resources are devoted to alfalfa production, which is exported to support China’s growing dairy industry (Pierson 2014). South American exports to Europe also increased over the twenty year period, as did internal European trade. The U.S. has remained the largest virtual water exporter, while China is now the largest importer (Dalin et al. 2012). Africa remains only marginally linked to virtual water networks (Carr et al. 2012).

4.3 Land and Food Production

Globalization, population growth, urbanization, and consumption and production patterns are driving and aggravating competing uses of land worldwide. Logging activity—legal and illegal, wildfires, and climate change are all drivers of deforestation and forest degradation. Clearing land for increased agricultural production and livestock grazing conflicts with forest preservation, pitting environmental goals against food security needs. The Atlantic Basin plays an important role in global food security issues, with countries such as the U.S., the EU, and Brazil serving as major producers and exporters of agricultural and food products. On the other side of the equation, the Atlantic Basin confronts serious food security challenges: Africa is home to over 40 percent of the world's hungry, possibly reaching three-quarters by 2025 (Guinan et al. 2012).

3.3.1. Soil, Water, and Food Production

Food security is inarguably a global challenge, but Atlantic production systems tell important stories. Industrial agriculture in the U.S. and Europe, often characterized by large-scale farms, the production of select marketable crops, heavy use of petrol and water, large inputs of pesticides and fertilizers and the use of genetically modified crops (GMOs), have come to influence food production systems worldwide, such as through food aid policies, the spread of Americanized agricultural systems during the Green Revolution, trade policies (e.g., NAFTA, WTO Agreement on Agriculture), and the rise of multinational agri-food companies (Frankel 1971; Hufbauer and Schout 2005; Fussell 1992; Diaz-Bonilla et al. 2000; Shattuck and Holt-Giménez 2010).

These systems have been successful in producing sizeable outputs, but with accompanying environmental impacts—affecting water and soil quality, contributing to carbon emissions, and increasing reliance on chemical applications as crop resistance grows. Mass production of profitable commodity crops such as corn, soy, and wheat are often heavily subsidized, driving down costs, with production targeted towards consumption for a growing middle class. For example, much of the world's soy is used as feed for poultry, pork, cattle, and farmed fish. Brazilian soy production has surpassed the U.S. in recent years in order to meet the needs of its growing cattle production, mostly for domestic meat consumption (Rudarakanchana 2014). However, as a result, agricultural land expanded into the Cerrado dramatically. What was once Brazil's most biodiverse savannah lost 42 percent of its natural vegetation between 1985 and 2005, with erosion increasing significantly (Grecchi et al. 2015).

Major new agricultural actors such as Brazil have adopted similar systems of industrial agriculture as Northern Atlantic countries, but at the expense of rapid land clearing of valuable biodiversity "hotspots" such as the Cerrado and the Amazon. Agricultural activities are the foremost threat to the Atlantic Forest and have reduced the rainforest in Brazil, Argentina, and Paraguay to seven percent of its original extent in the last forty years (Rudarakanchana 2014). Despite the rapid pace of growth and crop area expansion, Africa, Latin America, and the Caribbean still have relatively low yields in comparison to North America and Europe (UNEP 2012).

African agriculture operates below its potential productivity and is especially vulnerable to climate change impacts; however, producers in the North will also be impacted from increased temperatures and precipitation variability, as evidenced by, for example, the 2012 drought in the U.S. Midwest (World Bank 2012; Searchinger 2012). Increased precipitation and temperature variability in Sub-Saharan Africa and the Sahel will result in drought and scarce water resources, reducing agricultural yields and limiting carrying capacity in dry pastoral regions. Importers and exporters of agricultural products in the region will see significant shifts due to climate change. North Africa in particular is expected to impacted by climate change, with net food imports predicted to potentially be 230 to 480 percent higher by 2050 under climate change scenarios (Nelson et al. 2010).

Many developing countries in Latin America and Africa rely on the agricultural sector for a significant portion of economic activity and are responsible for employing a large proportion of the population. Latin America—and Brazil in particular—have been at the forefront of food security policies making significant achievements in reducing hunger through policy programs and technical capacity in tropical agriculture. South-South cooperation on food security issues between Brazil and African countries is taking place and Brazil is also actively engaged in working with several African countries in tropical agriculture and food security policy research and implementation (Cabral and Shankland 2013). Brazilian technology transfers and capacity building efforts in Africa have helped increase food supplies and stimulated additional interest in cooperation from other parts of Africa, Latin American, and the Caribbean (Contina and Martha 2012).

3.3.2. Obesity and Other Wastes of Food

From a social perspective, agricultural production and food security have important implications for urbanization, cultural traditions of food production by agrarian communities, and the global paradox of "stuffed and starved," referring to the increased frequency of obesity and related medical issues in some parts of the world and hunger and starvation in others (Patel 2007; Nestle 2002). Obesity now affects a significant proportion of individuals and both clinically overweight and underweight individuals are often found in the same country.

The majority of clinically overweight people live in urban areas in both developed and developing countries, while the majority of clinically underweight or food insecure people are found in rural areas and are subsistence farmers, working as producers of food (de Schutter 2014). Many other countries with fast growing economies are experiencing similar socio-cultural changes in diet and corresponding problems with high levels of obesity and chronic disease. With a 32.8 percent adult obesity rate, Mexico has now inched past the 31.8 percent obesity rate in the U.S. (FAO 2013). Further, the onset of fast food and processed products has contributed towards diets that are high in sugar and fat and lead to increasing cases of chronic disease such as diabetes and heart disease. Food waste, too, is increasingly identified as an important issue; crops are lost after harvest due to poor storage facilities, transport infrastructure and market access in developing countries and are thrown away or wasted before consumption in the developed world.

Adjustments to regional trade policies and harmonization can in theory help promote new opportunities for agricultural trade and offer greater benefits to developing countries, such as in Sub-Saharan Africa, though can also have negative impacts on sustainable land use, setting economic incentives for land conversion, and enabling disproportionate resource use and sharing between developed and developing countries. NAFTA resulted in severe environmental impacts—flooding Mexican markets with cheap U.S. corn, threatening Mexican agro-biodiversity—e.g., maize varieties—and local livelihoods while consumer food prices rose and unsustainable production models in the U.S. increased (Ackerman et al. 2003; Fox and Haight 2010).

The past few decades have also seen a rapid rise in the production of biomass fuels such as maize, sugar cane, palm oil, and rapeseed (UNEP 2012). Promoted as a renewable fuel that can reduce greenhouse gas emissions by actors such as the EU and U.S., large-scale biofuel production is accompanied by impacts related to land conversion and deforestation (negating climate benefits), extensive water use, effects on the global food market, and the purchase or leasing of land by foreign investors to produce food and biofuels (UNEP 2012). In the U.S., over 1.3 million hectares of conservation lands were lost in just over a year to support biofuel production (UNEP 2012). Palm oil is also a significant biofuel crop also linked to recent deforestation, with Columbia and Ecuador as leading producers (Magrin et al. 2014).

Within the Atlantic, agriculture poses both opportunities and challenges—such how to increase food production systems in developing countries in Latin America and Africa while protecting or maintaining ecosystems, biodiversity, and economic welfare for the large number of smallholder farmers, how to better the influence of production systems in the U.S. and Europe on diet choices, and how to move towards sustainable production and consumption.

3.3.3. Lungs of the Earth: The Forests of the Atlantic

South America's Amazon contains roughly one third of the world's remaining tropical rainforest and stores approximately 120 billion tons of carbon. Transpiration in the forest also has far reaching effects on rainfall throughout the Atlantic Basin (Schwartzman 2013). Moderate and localized deforestation enhances local convection and rainfall, but large-scale forest loss tends to reduce rainfall and impact regional circulation of atmospheric moisture. Removal of 30 to 40 percent of the forest could push much of Amazonia into a permanently drier climate regime (Malhi 2008).

Although the Amazon cuts across nine countries, 80 percent of deforestation has taken place in Brazil, driven by trade and global consumption of Brazilian beef and soybeans (Malhi 2008; Karstensen et al. 2013). Brazil was responsible for an estimated 2.7 billion tons of CO_2, or 30 percent of carbon emissions associated with deforestation, in the last decade, due to soybean production and cattle ranching.

The Amazon faces changes in precipitation under climate change scenarios and has already experienced a drying trend in the north, which may lead to eventual burning (Malhi 2008). The size and density of the Amazon Basin make it a crucial player in the effort to fight against climate change with rainforests acting as major absorbers of carbon. Increasing deforestation magnifies global warming because trees release the carbon they are storing when they are felled into the atmosphere. In the eastern part of the Amazon region, increases in temperature and decreases in soil humidity have lead to the expansion of savannahs, marking significant ecological shifts.

The other "lung" of the Atlantic, the Congo Basin, is the world's second largest contiguous block of tropical forest and covers 400 million hectares, storing an estimated 60 billion metric tons of carbon (Megevand 2013). Most falls within the Democratic Republic of the Congo. Deforestation rates in the Congo Basin have been relatively low compared to those observed in other tropical forests, in part due to tax receipts from oil and mineral industries (Rudel 2013). However, pressures are rising, such as increasing population density and demand for fuel wood and timber resources, and clearing of land for (largely small-scale) agriculture. Between 2000 and 2010, the highest rates of tropical forest loss occurred in South America and Africa (UNEP 2012).

4.4. Biodiversity

Conservation of biodiversity is critical for ensuring human well-being through the continued provision of ecosystem services. Areas of high biodiversity have the capacity to, amongst other functions, provide food and fuel and to regulate the environment through, for example, water purification and carbon storage (WWF 2012). Assessments indicate a declining status of global biodiversity, largely credited to anthropogenic-induced pressures such as land use change and extensive habitat loss, natural resource overexploitation, pollution, and the spread of invasive species. Changes in land use and land cover to meet growing energy, development, and food demands are causing detrimental habitat fragmentation and loss. For example, approximately 80 percent of remaining Atlantic Forest fragments are less than half a square kilometer in size (Butchart 2010).

Predictions suggest that in the future, while these will remain important pressures to biodiversity and ecosystem health, the threats posed by climate change will become more critical (Dawson et al. 2011). Climate change is anticipated to severely impact marine and terrestrial biodiversity and ecosystems, causing reduced fitness, decreased genetic diversity, forced migrations, habitat and food loss, phenological shifts, and altered species compositions and interspecific relationships (Cheung et al. 2009).

Within the Atlantic Basin, local extinctions are already seen in the tropics, the Southern Ocean, the North Atlantic, and the Mediterranean (Ibid.). Amazonian forests, which harbor perhaps a quarter of global terrestrial species, and Congo Basin forests, boasting high levels of biodiversity and endemism, are two examples of susceptible regions (Malhi 2008). There is increasing evidence that local species' extinctions and the effects of species loss on productivity and decomposition are already altering key ecosystem processes and accelerating broad-reaching changes across the globe (Hooper et al. 2012).

Latin America and the Caribbean have the greatest biological diversity in the world, with half the world's tropical forests, 33 percent of mammals, 35 percent of reptilian species, 41 percent of birds, and 50 percent of amphibians (UNEP 2010). Brazil alone is estimated to host between 15 to 20 percent of the world's biological diversity (CBD n.d.). South Africa is home to approximately ten percent of global plant species, sixty-five percent of which are endemic (Department of Environmental Affairs and Tourism 2009).

The high concentration of genetic resources in the global south and the widespread desire for access and usage rights by industry in the North—e.g., the EU, U.S., and Canada—create an additional dimension in the biodiversity dialogue. As developing countries in the South are frequently dependent on these resources, they are subject to a disproportionately high degree of vulnerability to declines in biodiversity and ecosystem service provisioning.

Traditionally, the biotechnological industry has been concentrated in developed countries in the North, while genetic resources are concentrated in the South. In 2011 for example, the U.S. was responsible for 40.5 percent of biotech patent applications filed under the Patent Cooperation Treaty system administered by the World Intellectual Property Organisation (WIPO), while the EU's share was 26.5 percent (OECD 2015). Southern Atlantic countries such as Brazil and South Africa were responsible for just 0.4 and 0.1 percent respectively. China, on the other hand, has increased its patent activity while Japan held the third largest number of applications at 11.2 percent (Ibid.)

At the international level, the Convention on Biological Diversity's Nagoya Protocol provides a legal framework for improved access and benefit sharing procedures for genetic resources with prior informed consent and mutually agreed upon terms, and negotiations have been undertaken, but stalled, in the WTO (TRIPS Agreement) and WIPO to require disclosure of the source of genetic materials in patent applications. Bilateral trade agreements and dialogues have helped fill gaps in improving access and benefit sharing for genetic resources, such as bilateral agreements between the EU and Latin American countries, and ongoing negotiations between the EU and MERCOSUR (Oberthür et al. 2011). On the other hand, agreements between developing and developed countries such, as EU Member States and the U.S., and developing countries sometimes exceed even TRIPS demands towards sovereign state rights over biological resources (Biermann et al. 2009).

Marine genetic resources follow a similar narrative. New discoveries in marine biotechnology in recent years have raised driven commercial interest in marine natural products and bioprospecting (Arrieta et al. 2009). Just a handful of countries own the majority of patents filed with WIPO: Between 1991 and 2009, 70 percent of genetic patents for marine organisms—themselves just two percent of all genetic patents—were dominated by the U.S., Germany, and Japan (Arnaud-Haond et al. 2011). The remaining of the top ten countries, who collectively own 90 percent of marine genetic patents, were France, the U.K., Denmark, Belgium, the Netherlands, Switzerland, and Norway (Ibid.). Bioprospecting for marine genetic resources often occurs outside of national jurisdictions and without regulation, although in 2015, countries agreed to develop a new legally binding instrument on marine biological diversity beyond areas of national jurisdiction.

4.5. Chemicals and Waste

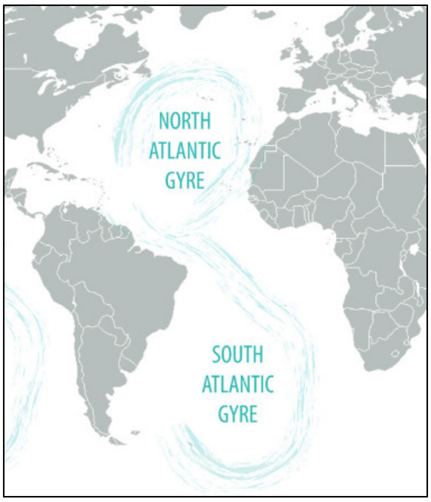
Escalating global production and chemical use necessitates sound life cycle management and sustainable practices to minimize adverse effects on human health and the environment. Chemical production has been shifting from OECD countries to developing countries, such as Brazil, with 20 percent of world production, China at 48 percent, India at 20 percent, and Russia at 12 percent (UNEP 2012). Chemical consumption in developing countries is also quickly growing. Much of global production is outsourced to developing countries from developed countries, which may lack capacity for adequate management of chemicals and waste. Additionally, through leakages of landfill gas, growing volumes in municipal solid waste landfills contribute to air pollution, including methane, a potent greenhouse gas.

Regulation of chemicals is by no means a local issue: For example, the EU's REACH (Registration, Evaluation, Authorisation, and Restriction of Chemicals) legislation has far-reaching extraterritorial effects. In order to enter the EU market, products must be REACH compliant, causing countries to adapt their products to REACH regulations. Several countries have also used EU REACH as a model to develop their own legislation, most notably China (CIRS 2014).

Many waste problems are more local in nature, but one aspect wider reaching links is disposal of electronic waste or "e-waste," referring to discarded electronic appliances. There is an interest in extracting for profit certain valuable materials found in the appliances. Reprocessing technologies for e-waste are expensive, oftentimes resulting in illegal exports of the waste to developing countries where environmentally unfriendly and unsafe measures are used to extract materials to sell on the black market, leading to toxic water and food chain contamination and health impacts for workers (Robinson 2009).

Global generation of e-waste is largely concentrated in the EU, U.S., and Australasia, although China and Latin America are anticipated to become major e-waste producers in the future (Ibid.). The majority of waste is shipped for reprocessing to China, but in the Atlantic Basin, Nigeria and Ghana are major recipients, as well as Brazil and Mexico (Ibid.). Most mobile phones end up in Hong Kong, as well as Latin American and Caribbean countries such as Guatemala, Peru, Colombia, Panama, and Paraguay. The main destinations for larger electronic items, mostly TVs and monitors, are China, Venezuela, Paraguay, and Mexico. According to Interpol, nearly one in three containers departing from the EU contains illegal e-waste (Vidal et al. 2013).

Figure 3. The Atlantic gyres (Gold et al. 2013).



Marine pollution from macro- and micro-plastics is a major environmental concern and composes 60 to 80 percent of all ocean debris (Moret-Ferguson et al. 2010). Plastic and other debris discarded in one location inevitably ends up in the shared commons of the ocean and on the shores of other countries with substantial environmental, as well as socioeconomic, problems. In the Atlantic Ocean, the highest concentrations of plastic debris have been observed in subtropical ocean gyres (Law 2010; Moret-Ferguson et al. 2010).

The Atlantic Ocean is home to two major marine litter "garbage patches." Regional studies of the Baltic Sea, Northeast Atlantic, U.S. coastline, and North Atlantic Subtropical Gyre indicated no statistically significant changes in litter quantity between 1986 and 2008 (UNEP 2012). Meanwhile, data from the Mid-Atlantic showed an increase in marine litter in the late 1990s and early 2002. While international agreements such as UNCLOS, the Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter (London Convention), and the International Convention for the Prevention of Pollution from Ships (MARPOL) have the potential to address marine plastics, some of the most promising work to date has occurred within regional frameworks such as the OSPAR and Barcelona Conventions and EU's Marine Strategy Framework Directive (Gold et al. 2013).

6. Inter- and Intra-Basin Dynamics

While the Atlantic Basin has strong internal dynamics, as described herein, it is not entirely self-contained nor a closed system. Players both inside and external to the Basin influence and are affected by environmental challenges in the Atlantic space. Actors from outside of the Basin consume resources, contribute to pollution, and shape developments, including via trade, foreign direct investment, and technology transfer. The future of the Atlantic Basin is likely to be increasingly influenced by emerging actors in the Southern Atlantic, shifting away from traditional North-North and North-South dynamics as the South's populations, power, and consumption rise (Lesser 2010).

The growing influence of developing countries outside of the Atlantic Basin, such as China and India, will influence Atlantic production, consumption, and environmental effects. Rising demand for resources to feed growing—and wealthier—populations is shifting global production and consumption patterns, and in turn, drivers of environmental degradation.

While air pollution in Europe and North America has improved in response to policy targets, pollution from Asia is largely continuing upwards due to rapid industrialization. China has leapfrogged to become the world's greatest energy user and greenhouse gas emitter—with India, Russia, and Indonesia following behind the second and third place U.S. and EU. However, China has also become the world leader in renewable energy investment and shifted solar PV production away from markets in Germany and the U.S.

It is possible that the Atlantic Basin may still become a critical supplier-region of hydrocarbons at the margin for satisfying growing Asia-Pacific energy consumption. Shifting energy supply and demand in the Atlantic Basin will also alter external relationships; for example, dependencies of Western countries on Middle Eastern oil may weaken as intra-Basin energy trade increases, altering traditional geopolitical relationships and influences (Isbell 2012). Yet today this path appears increasingly unlikely as oil and gas prices have fallen significantly, reducing the impetus for pursuing development of expensive unconventional fossil fuel sources. At the same time, the costs for renewable energy technologies, such as solar, and costs for energy storage, are falling rapidly, opening the door for a new renewable energy future in the Atlantic.

To help support growing resource demand and populations, some hypothesize that countries such as China and the as Persian Gulf States have taken to investing in land and freshwater and other resources in regions such as Africa and Brazil—sometimes controversially referred to as "land grabs"—particularly in Sub-Saharan Africa (Gerstetter et al. 2011; Rulli et al. 2013). The extent and nature of these investments and their implementation, however, is still unclear and debated, as is to what degree local stakeholders, such as smallholder farmers, are disenfranchised, or benefit from economic opportunities (Searchinger 2012; Pearce 2013; Woertz 2013).

What is clear is that an increasingly globalized world and economy, the Atlantic region is far from isolated. Environmental challenges experienced in the pan-Atlantic are inextricably connected to actors outside of the four regions. Moreover, solutions to global environmental challenges must ultimately entail cooperation from actors within and outside of the Basin. At a biophysical level, too, while the Atlantic displays distinctive properties and dynamics, its systems are parts of the global Earth system. Atlantic currents are ultimately connected to and shaped by Pacific and Indian Ocean processes.

7. Conclusions

This paper describes the pan-Atlantic biosphere in terms of geography and biology, as well as human activities, institutions, and policies that are relevant to the management of natural resources and the environment. We first look at the Atlantic Ocean and the dynamics within, as the foundation for the region's environmental landscape.

Taking an Earth systems approach, five areas were selected for examination: climate change and the atmosphere, including energy systems and policy; the Atlantic watershed, including freshwater, fish, and minerals; land, and the (agricultural) production of food, feed, fuel, and associated issues; biodiversity, its state, the threats to it, its protection, and its appropriation; and chemicals and waste, including their trade, and marine litter in the Atlantic Ocean's gyres.

As is generally appropriate for the study of semi-enclosed systems, we looked to the links and dynamics within the Atlantic Basin, as well as those linking the Basin with other oceans: the somewhat separate regional seas with connections only to the Atlantic: Caribbean, Mediterranean (with the Black Sea behind), the North Sea (with the Baltic Sea behind) and are themselves semi-enclosed; the Arctic Ocean that, although also open to the Pacific Basin is in many ways an extension of the Atlantic Basin, and the links to the Indian and Pacific Oceans, and the Southern or Antarctic Ocean.

The pan-Atlantic is not an abstract of concept, but is realized through a complex network of natural linkages. Anthropogenic patterns of resource use and consumption provide further connections between Europe, Africa, and the Americas.
The "Atlantic Lifestyle" has been and is overusing natural resources and eroding natural ecosystems, and reducing their ability to support human and other life into the future; it is unsustainable. To oversimplify, this is linked to a historic exploitation of "the South" by "the North," leading to inequalities persisting today.

More recently, and so far to an insufficient extent, the North (EU, U.S., Canada) has shown leadership in addressing environmental and resource challenges. North-South geopolitical dynamics are shifting alongside growing political and economic weight in Southern Atlantic countries and there are growing examples of South-South environmental cooperation and leadership. Still, there remains unmet potential for North-South cooperation through, for instance, bilateral exchange, technical support, and capacity building.

The Atlantic is an area where some degree of policy coordination through international institutions has been achieved, but there is room, and need, for more. Mechanisms for international coordination in the region are generally not pan-Atlantic, but regional (within the Basin) and specific to challenges or sectors; there is no mechanism for building a holistic understanding of the Atlantic Basin as a whole.

We find that common or shared histories, languages, and values can provide a basis for addressing mutual challenges, while also recognizing the differences within the Atlantic Basin, notably between rich and poor countries, and the obstacles and potential for disagreement. Beyond shared biological and physical environments, Atlantic Basin countries share common histories and starting points. Colonial histories produced important commonalities in legal systems and policy structures, with implications for contemporary policy learning. Shared language and culture can provide a foundation for cooperation from which to address environmental issues from a wide variety of actors and institutions.

Constructions of new environmental regionalism, utilizing natural boundaries and ecoregions as well as cultural and economic aspects, reveal the pan-Atlantic’s nature and potential to promote common solutions. The Atlantic Basin’s environmental challenges cannot be adequately understood without an understanding of its biophysical realities. Nor can drivers of these challenges be understood or solutions realized without regional economic, cultural, and political dynamics.

Nonetheless, it would be simplistic to suppose that the challenges or solutions of the Atlantic can be considered in isolation. External actors increasingly influence the Atlantic environment through production and consumption patterns. Likewise, while there are powerful connections joining the pan-Atlantic together at a natural level, the region is ultimately part of and connected to the broader, global Earth system. Yet regional constructs cannot be overlooked and not only help to conceptualize key environmental dynamics, but regional policy solutions can serve as intermediaries of sorts between the global and state or local and offer new policy ideas and instruments. We conclude that the Atlantic is a biophysical reality, and a useful geographical unit of analysis for natural processes as well as human exploitation of them and the consequences of doing so. Rather than an immense separation between people and states, the Atlantic Ocean serves as a connector between continents.

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