Part II

CLIMATE CHANGE AND THE OCEANS

7

Impacts of Climate Change on Marine Ecosystems

Yvon Le Maho and Joël Durant

CLIMATE CHANGE INCREASES FISHERIES MANAGEMENT CHALLENGES

Fisheries management is facing unprecedented challenges. The superimposition of climate change on over-exploitation of resources is increasingly leading to unanticipated changes in marine ecosystems. Exploited fish species exhibit higher temporal variability than unexploited species.[1] Still, our understanding of the dynamics of fish abundance in marine ecosystems remains limited, because it is based on observations of quite a narrow range of climatic and ecological conditions. This results in uncertainty about the ability to predict future dynamics. Accordingly, there has been increasing appreciation of the fact that ecosystem management requires a more holistic approach,[2] a solid understanding of interdependent effects[3] and an ecosystem-based approach that integrates populations, food webs and fish habitats at different scales.[4]

[1] C.H. Hsieh, C.S. Reiss, J.R. Hunter, J.R. Beddington, R.M. May and G. Sugihara, 'Fishing Elevates Variability in the Abundance of Exploited Species', *Nature*, Vol. 443, 2006, pp. 859–862.

[2] L.W. Botsford, J.C. Castilla and C.H. Peterson, 'The Management of Fisheries and Marine Ecosystems', *Science*, Vol. 277, 1997, pp. 509–514.

[3] N.C. Stenseth, A. Mysterud, G. Ottersen, J.W. Hurrell, K.-S. Chan and M. Lima, 'Ecological Effects of Climate Fluctuations', *Science*, Vol. 297, 2002, pp. 1292–1296.

[4] P.M. Cury, Y.-J. Shin, B. Planque, J.M. Durant, J.M. Fromentin, S. Kramer-Schadt, N.C. Stenseth, M. Travers and V. Grimm, 'Ecosystem Oceanography for Global Changes in Fisheries', *Trends in Ecology and Evolution*, Vol. 23, 2008, pp. 338–346.

PHYSICAL INFLUENCES ON MARINE ECOSYSTEMS

Fisheries have long been concerned with the effects of the variability in weather and physical oceanographic conditions, in order to make year-to-year adjustments in management. In addition to local physical variables like sea temperature, fishery biologists have recently started to use global-scale climate indices. This has been a major step towards explaining ecological patterns and processes in marine ecosystems.[5] Two of the best-known such climate indices are the North Atlantic Oscillation (NAO) and the El Niño/ Southern Oscillation (ENSO) in the Pacific, but every single region of the world has its own. These large-scale climate patterns (alternation in atmospheric mass between two distant spots) provide a conceptual framework for a broader understanding of observed changes in the local physical environment.

Particular focus has been put on the time and spatial variability of abundance in target populations. One of the best examples concerns ENSO, the coupling of changes in the atmosphere and in the ocean which occurs in the Pacific in irregular cycles.[6] El Niño events are marked by the redistribution of a large pool of warmer surface waters in the eastern Pacific that expands to cover the tropics. The ecological consequences of the El Niño events include a decline in primary productivity near the Equator, a decline in zooplankton productivity in the California Current, and diminished survival and growth of some fish species such as anchovy, mackerel and salmon. Millions of seabirds which usually breed in the Galapagos archipelago fail in breeding during those El Niño years,[7] and fisheries collapse along the coast of Peru. Nor are ENSO effects limited to the Pacific; they are also essentially involved in the extension of warmer waters as far south as the Southern Ocean.[8]

---

[5] Stenseth et al., 'Ecological Effects of Climate', pp. 1292–1296; N.C. Stenseth and A. Mysterud, 'Weather Packages: Finding the Right Scale and Composition of Climate in Ecology', *Journal of Animal Ecology*, Vol. 74, 2005, pp.1195–1198; N.C. Stenseth, G. Ottersen, J.W. Hurrell, A. Mysterud, M. Lima, K.S. Chan, N.G. Yoccoz and B. Adlandsvik, 'Studying Climate Effects on Ecology through the Use of Climate Indices: The North Atlantic Oscillation, El Niño Southern Oscillation and Beyond', *Proceedings of the Royal Society of London B*, Vol. 270, 2003, pp. 2087–2096.

[6] S.G. Philander and A. Fedorov, 'Is El Niño Sporadic or Cyclic?', *Annual Review of Earth and Planetary Sciences*, Vol. 31, 2003, pp. 579–594.

[7] P.D. Boersma, 'Breeding Patterns of Galápagos Penguins as an Indicator of Oceanographic Conditions', *Science*, Vol. 20, 1978, pp. 1481–1483.

[8] Y.-H. Park, F. Roquet and F. Vivier, 'Quasi-stationary ENSO Wave Signals versus the Antarctic Circumpolar Wave Scenario', *Geophysical Research Letters*, Vol. 31, 2004, L09315.

It has been suggested that current global warming trends may increase the frequency of El Niño events,[9] inducing drastic changes in the distribution of water temperatures in the Pacific Ocean. Such change may have an important effect on fisheries. For instance, the skipjack tuna *Katsuwonus pelamis,* a medium-sized perciform fish that dominates the world tuna catch, has a fishing ground extending over 6000 km along the Equator. Inside this wide area, spatial distribution of the skipjack population is linked to large displacements of the warm-water pool that occur during El Niño events.[10] Their drastic zonal displacements associated with ENSO have important implications for the commercial tuna fishing industry.

It is now known that large-scale changes, or 'regime shifts', occur across entire ocean basins every few decades.[11] The best documented of these regime shifts, which has helped us to better understand how the physical environment alters ocean ecosystems, occurred in the mid-1970 in the North Pacific Ocean.[12] An intensification of the Aleutian low-pressure systems resulted in a shift from cooler to warmer waters and in an increase in the depth of the mixed layer.[13] Important biological consequences attributed to these physical changes include an increase in chlorophyll concentrations[14] and in Alaskan salmon catches.[15] The most spectacular was, however, that fish (gadoids and flatfish) replaced shrimp as the dominant catch in the northern Gulf of Alaska.[16] Another example of biological shifts is the opposite changes observed in populations of sardines and anchovy in coastal eco-

---

[9] A. Timmermann, J. Oberhuber, A. Bacher, M. Esch, M. Latif and E. Roeckner, 'Increased El Niño Frequency in a Climate Model Forced by Future Greenhouse Warming', *Nature*, Vol. 398, 1999, pp. 694–697.

[10] P. Lehodey, M. Bertignac, J. Hampton, A. Lewis and J. Picaut, 'El Niño Southern Oscillation and Tuna in the Western Pacific', *Nature*, Vol. 389, 1997, pp. 715–718.

[11] L.W. Botsford, J.C. Castilla and C.H. Peterson, 'The Management of Fisheries and Marine Ecosystems', *Science*, Vol. 277, 1997, pp. 509–514.

[12] S.R. Hare and N.J. Mantua, 'Empirical Evidence for North Pacific Regime Shifts in 1977 and 1989', *Progress in Oceanography*, Vol. 47, 2000, pp. 103–145.

[13] N.E. Graham, 'Decadal-scale Climate Variability in the Tropical and North Pacific during the 1970s and 1980s: Observations and Model Results', *Climate Dynamics*, Vol. 10, 1994, pp. 135–162; A.J. Miller, D.R. Cayan, T.P. Barnett, N.E. Graham, J.M. Oberhuber, 'Interdecadal Variability of the Pacific Ocean: Model Response to Observed Heat Flux and Wind Stress Anomalies', *Climate Dynamics*, Vol. 9, 1994, pp. 287–302.

[14] E.L. Venrick, J.A. McGowan, D.R. Cayan, T.L. Hayward, 'Climate and Chlorophyll a: Long-Term Trends in the Central North Pacific Ocean', *Science*, Vol. 238, 1987, pp. 70–72.

[15] W.G. Pearcy, *Ocean Ecology of North Pacific Salmonids* (Seattle, WA: University of Washington Press, 1992), p. 179; Botsford et al., 'The Management of Fisheries', pp. 509–514.

[16] D.L. Alverson, 'A Review of Commercial Fisheries and the Steller Sea Lion (*Eumetopias jubatus*): The Conflict Arena', *Reviews in Aquatic Sciences*, Vol. 6, 1992, pp. 203–256; Hare and Mantua, 'Empirical Evidence for Regime Shifts', pp. 103–145.

systems, as when sardine catches increased after the decline of the anchovy in the Pacific off Peru and Chile in the mid-1970s. By contrast, on the other side of the Pacific, catches of Japanese sardine rose at the same time.[17] Thus, opinion increasingly holds that, rather than being due to fishing, these regime shifts result from long-term and wide-scale changes in physical conditions.

There is still a need to conduct studies at finer spatial and temporal scales (e.g., meso-scale) than the scale of these global scale climate indices (i.e., yearly and continent scales) in order to understand how variability in the physical environment may be responsible for important biological changes. As examples we can cite the effect of upwelling winds on primary productivity,[18] and the importance of calm periods that allow for the feeding of larval fishes.[19] Furthermore, upwelling winds drive meso-scale mass circulation of water. This circulation, which operates at spatial scales between about 10 and 100 km and temporal scales of several days, determines the transport of planktonic larvae and accordingly the recruitment of fish populations.[20] Ultimately, these short-term variations may explain year-to-year variation in the spatial pattern of recruitment.[21]

FISH RECRUITMENT AND MESO-SCALE EVENTS

'Recruitment' is an essential concept in ecology. It refers to the number of organisms e.g., fish, that survive until they are large enough to be counted by an observer. In fishery biology, recruitment is classically the number of fish

---

[17] Botsford et al., 'The Management of Fisheries', pp. 509–514.

[18] C.T. Taggart and K.F. Frank, 'Perspectives on Larval Fish Ecology and Recruitment Processes: Probing the Scales of Relationships', in K. Sherman, L.M. Alexander (eds), *Patterns, Processes, and Yields of Large Marine Ecosystems* (Washington DC: American Association for the Advancement of Science, 1990), pp.151–164.

[19] R. Lasker, 'Field Criteria for Survival of Anchovy Larvae – The Relation between Inshore Chlorophyll Maximum Layers and Successful First Feeding', *Fishery Bulletin*, Vol. 73, 1975, pp. 453–462.

[20] T.M. Farrell, D. Bracher and J. Roughgarden, 'Cross-shelf Transport Causes Recruitment to Intertidal Populations in Central California', *Limnology and Oceanography*, Vol. 36, 1991, pp. 279–288; S.R. Wing, L.W. Botsford, J.L. Largier and L.E. Morgan, 'Spatial Structure of Relaxation Events and Crab Settlement in the Northern California Upwelling System', *Marine Ecology Progress Series*, Vol. 128, 1995, pp. 199–211.

[21] C.H. Peterson and H.C. Summerson, 'Basin-scale Coherence of Population Dynamics of an Exploited Marine Invertebrate, the Bay Scallop – Implications of Recruitment Limitation', *Marine Ecology Progress Series*, Vol. 90, 1992, pp. 257–272; L.W. Botsford, 'The Influence of Spatially and Temporally Varying Oceanographic Conditions on Meroplanktonic Metapopulations', *Deep-Sea Research*, Vol. 41, 1994, pp. 107–145; Botsford et al., 'The Management of Fisheries', pp. 509–514.

that become large enough to be fished. For some stocks, the fish are recruited/caught in fisheries at a mature age (for instance in the Norwegian spring-spawning herring, *Clupea harengus*, along the Norwegian coast). However, that is not the case for other species, such as the Northeast Arctic cod *Gadus morhua* in the Barents Sea, since its recruitment is at three years of age while maturation is usually reached at six to seven years of age. Altogether, the recruited individuals form the most influential part of the population (driving the population dynamics) and the more visible. This also applies to other animals, like seabirds that are usually counted while on land for breeding.

Accumulating evidence shows that the ocean is much richer than anticipated in meso-scale structures (structures between about 10 and 100 km) such as fronts related to upwellings, river plumes, eddies or strong flows at the interface between two water masses. These meso-scale structures determine the distribution and abundance of marine populations – their recruitment. They are now accessible through remote satellite sensing or by using instruments carried by seabirds or sea mammals. Steady advances in technology, such as miniaturization, and statistic tools, such as spectral and wavelet analyses, have brought about tremendous developments in remote sensing to identify, characterize and track these oceanographic features.[22]

Meso-scale events are connected to smaller-scale structures, such as turbulences, and larger-scale atmospheric and oceanic processes, such as the ENSO, NAO or Pacific Decadal Oscillation index. This teleconnection is illustrated by the fact that the greater the intensity of the California Current, the larger is the number of meso-scale eddies.[23] Importantly, these eddies constitute suitable retention areas for sardine eggs in the Pacific region.[24]

Moreover, biophysical models (models that include environmental and biological parameters) operating at the meso-scale have also been developed, as by coupling high-resolution hydrodynamic models describing ocean currents with models of the occurrence and distribution of fish eggs and

---

[22] P. Miller, 'Multi-spectral Front Maps for Automatic Detection of Ocean Colour Features from SeaWIFS', *International Journal of Remote Sensing*, Vol. 25, 2004, pp. 1437–1442; A.M. Doglioli, B. Blanke, S. Speich and G. Lapeyre, 'Tracking Coherent Structures in a Regional Ocean Model with Wavelet Analysis: Application to Cape Basin Eddies', *Journal of Geophysical Research*, Vol. 112, 2007, C05043; M. Segond, S. Mahler, D. Robilliard, C. Fonlupt, B. Planque and P. Lazure, 'Ant Algorithm for Detection of Retentive Structures in Coastal Waters', in P. Liardet, P. Collet, C. Fonlupt, E. Lutton and M. Schoenauer (eds), *Artificial Evolution, LNCS 2936* (Berlin and Heidelberg: Springerg, 2004), pp. 166–176.

[23] A. Bakun, 'Regime Shifts', in A.R. Robinson and K. Brink (eds), *The Sea*, Vol. XIII (Cambridge, MA: Harvard University Press, 2005), pp. 971–1026.

[24] Ibid.

larvae. Such models have successfully been used to determine the spawning habitats and recruitment dynamics of the haddock in the North Sea[25] and anchovy in the Benguela current region[26] and Bay of Biscay.[27]

BOTTOM–UP AND TOP–DOWN CONTROLS OF FOOD WEBS

Ecosystems are composed of species that are in relation with each other. The main relation link is the trophic interaction: who eats whom, and who is eaten by whom. Understanding an ecosystem therefore essentially requires investigating the trophic interactions inside it, the 'food-web'. Aquatic food webs have been studied intensively with respect to the effects on species composition and abundance of trophic interactions between consumers and resources. Following this, various types of control have been suggested, depending if the system is controlled by the environment (bottom–up), i.e., through the plankton production depending on physical conditions; by predation (top–down); or by a combination of both (e.g., wasp-waist control). However, the control of marine food-webs is dynamic and may switch between control types. For example, the variations in major resources in the North Sea have been recently explained by environmental forcing, i.e., a bottom–up control,[28] while another study has shown the effect of fisheries, i.e., a top–down control.[29] Yet, bottom–up and top–down controls may act in synergy. For example, in the heavily exploited regions of the northwest Atlantic, both primary productivity and fish species diversity at the high trophic levels (top predators) determine whether a trophic cascade occurs.[30]

---

[25] M.R. Heath and A. Gallego, 'Bio-physical Modelling of the Early Life Stages of Haddock, *Melanogrammus aeglefinus,* in the North Sea', *Fisheries Oceanography*, Vol. 7, 1998, pp. 110–125.

[26] C. Parada, C.D. van der Lingen, C. Mullon and P. Penven, 'Modelling the Effect of Buoyancy on the Transport of Anchovy (*Engraulis capensis)* Eggs from Spawning to Nursery Grounds in the Southern Benguela: An IBM Approach', *Fisheries Oceanography*, Vol.12, 2003, pp.170–184.

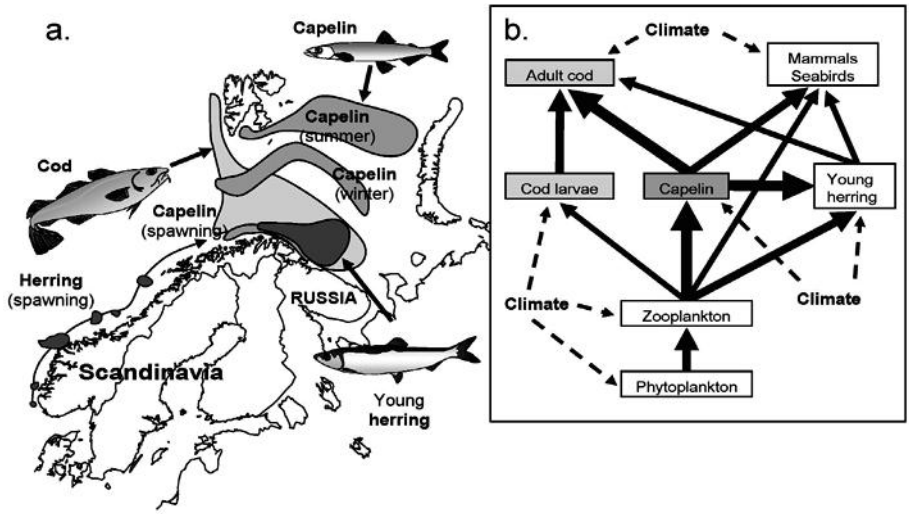
[27] G. Allain, P. Petitgas, P. Grellier and P. Lazure, 'The Selection Process from Larval to Juvenile Stages of Anchovy (*Engraulis encrasicolus)* in the Bay of Biscay Investigated by Lagrangian Simulations and Comparative Otolith Growth', *Fisheries Oceanography*, Vol. 12, 2003, pp. 407–418.

[28] G. Beaugrand, K.M. Brander, J.A. Lindley, S. Souissi and P.C. Reid, 'Plankton Effect on Cod Recruitment in the North Sea', *Nature*, Vol. 426, 2003, pp. 661–664.

[29] D. Pauly and J. MacLean, *In A Perfect Ocean: The State of Fisheries and Ecosystems in the North Atlantic Ocean* (Washington DC: Island Press, 2003).

[30] K.T. Frank, B. Petrie, N.L. Shackell and J.S. Choi, 'Reconciling Differences in Trophic Control in Mid-latitude Marine Ecosystems', *Ecology Letters*, Vol. 9, 2006, pp. 1–10.

Figure 7.1 The simplified Lofoten-Barents Sea Ecosystem



a. Distribution of cod (light grey) and capelin (grey) and herring (darker grey). After winter the spawning capelin migrates southward to breed by the Norwegian coast where they are heavily predated by cod. In spring the herring spawns along the Norwegian coast, the resulting larvae drifting passively with the Norwegian coastal current (arrow), which runs northwards to the Barents Sea.

b. Description of the food-web in the Lofoten-Barents Sea pelagic ecosystem. This ecosystem can be simplified taking into account only the main components of the food web (Plankton, Capelin, Herring, Cod and top predators – seabirds and marine mammals). The strengths of the trophic relationships between the main components of the food-web, including cod cannibalism, are indicated using arrows of differing thicknesses. The direction of the arrow indicates who eats whom; for instance, the phytoplankton is eaten by the zooplankton. All elements of the food web are affected by the climate (NAO, sea temperature…).

Source: Adapted from Durant et al. 2007 and Cury et al. 2008[31]

Another example is the Lofoten-Barents Sea pelagic ecosystem (Fig. 7.1), with three main fish species: the Norwegian spring-spawning herring, which spawns near the southern Norwegian coast and spends its maturing two to three first years of life in the Barents Sea; the Northeast Arctic cod, the world's largest stock of Atlantic cod, which spawns in the Lofoten along the northern Norwegian coast; and the capelin (*Mallotus villosus*), which feeds in the highly productive area of plankton by the ice-edge and then migrates to the northern coasts of Norway and Russia to spawn and die. Using time-

[31] Adapted from J.M. Durant, D.Ø. Hjermann, P.S. Sabarros and N.C. Stenseth, 'Northeast Arctic Cod Population Persistence in the Lofoten-Barents Sea System under Fishing', *Ecological Application*, Vol. 18, 2008, pp. 662–669, and Cury et al., 'Ecosystem Oceanography', pp. 338–346.

series of environmental variables (the NAO and sea temperature), it has been possible to draw a food-web diagram for the Barents Sea pelagic ecosystem and understand the controls[32] (Fig. 7.1). All populations and communities of the food-web are affected by climate. However, cod populations are essentially controlled by capelin abundance, but also by the cannibalism on young cod by older individuals. Capelin and young herring are controlled by adult cod, by marine mammals and seabirds, as well as by zooplankton, which is controlled by phytoplankton. Zooplankton is also controlled by cod larvae, capelin and young herring. Young herring depend largely on capelin, so a high biomass of herring in the Barents Sea will tend to increase the self-regulation of the cod stock. Because young herring feed on capelin, this prey will be less available for older cod, which in turn will lead to cannibalism of cod larvae and young. This highlights the importance of integrating food-web dynamics when modelling the dynamic environmental forcing of marine ecosystems. It also points up the need to take into account food-web dynamic when fixing fishing quotas, as no fish stock can be managed efficiently without conjointly managing the prey stock often also targeted by fisheries.[33]

COUPLING OF THE EFFECTS OF THE ENVIRONMENT WITH FISH DYNAMICS AND EVOLUTION

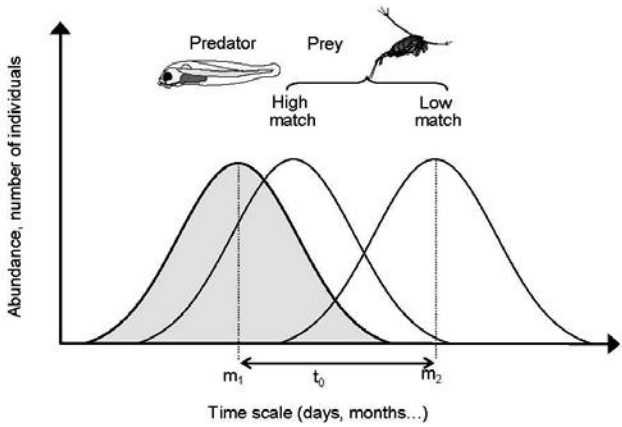
Three levels of organization have to be considered: population, food-web and ecosystem. For example, in analysing the heavily fluctuating number of young herring and cod in the northern Atlantic, control was thought to be operated by planktonic food abundance (hence bottom–up controlled). The central process to be studied accordingly seemed to be the starvation of fish larvae and the recruitment of their cohort (group of the same age) to the population. In this approach, the survival of the larvae is essential. In 1914, in his seminal work, Johan Hjort suggested that larvae survival depends on the period when they have to feed for the first time,[34] that is, when the reserves of their yolk sacks are exhausted. This approach was further refined with the 'match–mismatch' hypothesis (Fig. 7.2, MMH), according to which

[32] D.Ø. Hjermann, B. Bogstad, A.M. Eikeset, G. Ottersen, H. Gjøsæter and N.C. Stenseth, 'Food Web Dynamics Affect Northeast Arctic Cod Recruitment', *Proceedings of the Royal Society of London B*, Vol. 274, 2007, pp. 661–669; D.Ø. Hjermann, N.C. Stenseth and G. Ottersen, 'Indirect Climatic Forcing of the Barents Sea Capelin: a Cohort Effect', *Marine Ecology Progress Series*, Vol. 273, 2004, pp. 229–238.

[33] Durant et al., 'Northeast Arctic Cod Population Persistence'.

[34] J. Hjort, 'Fluctuations in the Great Fisheries of Northern Europe Viewed in the Light of Biological Research', *Rapport et Procès-verbaux des Réunions du Conseil international pour l'Exploration de la Mer*, Vol. 20, 1914, pp. 1–228.

Figure 7.2 The match–mismatch hypothesis



Fish larvae hatch, plankton bloom and other biological events can be described by a bell-shaped curve (the maximum date is on the graph located by 'm' in the time axis). A high match, i.e., good feeding possibilities for the predator, is represented by a temporal overlap of the predator (here cod larvae, the grey shaded curve) and its prey (here copepod, the open curves). This overlap is not every year the same, since the different events may fluctuate in time due to climatic variations. An increase of the time-lag (t_0) between the two populations leads to a low match: a small or non-existent overlap, e.g., bad feeding conditions for the predator, and high mortality. It is the time overlap between the two populations (the degree of mismatch; m_1-m_2) that determines the survival of the predator larvae.

Source: Adapted from Durant et al. 2007[35]

larval survival is determined by the seasonal correspondence between the timing of planktonic food production and the timing of fish larval yolk-sack depletion.[36] This hypothesis, originally formulated to describe a temporal relationship between juvenile fish and plankton in a bottom–up controlled system, was later broadened to other age-groups and species, to another spatial dimension[37] and to top–down systems.[38] More generally, MMH states that growth and survival of predators depend on the synchronous availability

[35] Adapted from Durant et al., 'Climate and the Match or Mismatch'.

[36] D.H. Cushing, 'Plankton Production and Year Class Strength in Fish Populations: an Update of the Match/Mismatch Hypothesis', *Advances in Marine Biology*, Vol. 26, 1990, pp. 249–293; D.H. Cushing, 'The Regularity of the Spawning Season of Some Fishes', *Journal du Conseil permanent International pour l' Exploration de la Mer*, Vol. 33, 1969, pp. 81–92.

[37] J.M. Durant, D.Ø. Hjermann, G. Ottersen and N.C. Stenseth, 'Climate and the Match or Mismatch between Predator Requirements and Resource Availability', *Climate Research*, Vol. 33, 2007, pp. 271–283.

[38] J.M. Durant, D.Ø. Hjermann and N.C. Stenseth, 'Reversing the Match–mismatch Relationship: The Prey Point of View', paper presented at ICES Annual Science Conference in Berlin, 21–25 September, 2009.

of their main prey[39] (conversely, in a predator controlled system the top-down MMH states that the prey thrives if it is a-synchronous with the predator). However, it then became evident that the influence of wind and current on the potential drift of fish and larvae also have an important role.

In this context, environmental changes (human or natural) may lead to the displacement of the respective optimum variables, such as temperature, therefore inducing a change in the distribution area of various species. Because different species show unique responses to environmental changes, climate change may have unexpected consequences. Importantly, not all components of food chains will respond in the same way and at the same rate and thus remain synchronous and matching. This means that the effects observed at the lower trophic levels of the marine ecosystems can affect all the elements of the food-chain – the predator at the top of the chain showing the strongest response. This may be of a particular economic significance when predators are exploited by fisheries.

From this perspective, the effect of climate change will be to weaken the synchrony between food availability and the need for food of the targeted fish species, invariably leading to lower survival of the larvae. We can identify three theoretical effects of climate change on phenological mismatch:[40]

- change in the mean relative timing of predators and prey;
- change in the level of prey abundance; or
- change in the amplitude of year-to-year variations in prey timing in regions where interannual variability in temperature is expected to increase, such as polar regions.

In the first case, apart from the presence in the system of alternative prey, the fish stock will decrease dramatically, perhaps leading to a closure of the fisheries. In the second case, prey abundance will be too low to sustain the fish stock, reducing the possibilities for fishing, as with North Sea cod.[41] Finally, in the third case there will be a highly irregular abundance of prey, making the fish population extremely sensitive to fishing and the catch of its spawning individuals.

---

[39] Beaugrand et al., 'Plankton Effect on Cod Recruitment', pp. 661–664; J.M. Durant, D.Ø. Hjermann, T. Anker-Nilssen, G. Beaugrand, A. Mysterud, N. Pettorelli, N.C. Stenseth, 'Timing and Abundance as Key Mechanisms Affecting Trophic Interactions in Variable Environments', *Ecology Letters*, Vol. 8, 2005, pp. 952–958; Durant et al., 'Climate and the Match or Mismatch', pp. 271–283.

[40] Cury et al., 'Ecosystem Oceanography', pp. 338–346.

[41] G. Beaugrand, K.M. Brander, J.A. Lindley, S. Souissi and P.R. Reid, 'Plankton Effect on Cod Recruitment in the North Sea', *Nature*, Vol. 426, 2004, pp. 661–664.

According to Sinclair,[42] ocean hydrodynamics must be considered as well, since, in line with 'member/vagrant' hypothesis there should be retention of fish within suitable areas during their early life history. An important consequence for the exploitation of marine resources is therefore that not only temporal but also spatial aspects must be taken into consideration. For example, the herring population in the North Sea includes multiple subpopulations which reunite during the feeding season but separate during the spawning season. This means that the survival of early herring life-stage should be investigated at the level of subpopulations, i.e., at the spatial level.[43] A unifying framework that integrates the match–mismatch and member/vagrant hypothesis has then been developed by Bakun,[44] who terms this synthesis for ecosystem oceanography the 'fundamental triad' of production, concentration and retention.

Ecology was until recently considered from a static point of view, with the relationships and equilibrium described seen as 'permanent'. In the wake of the discovery of global warming, ecologists have now started to envisage the possibility of change in the ecosystems (regime shifts, dynamic control of the ecosystem) and also to consider the ecosystem in an evolutionary perspective. Harvesting does affect stock size, but pronounced changes in life-history traits (referring to the reproductive cycle) can also be observed. For example, the Northeast Arctic cod in the Barents Sea, a very important economic resource, experienced a reduction in mean age and size at maturation following the intensification of fishing pressure in the 1930s to 1950s.[45] There is growing evidence that harvesting can cause rapid evolution of key yield-determining life-history traits such as age and size at maturation.[46] This

---

[42] M. Sinclair, *Marine Populations: An Essay on Population Regulation and Speciation* (Seattle, WA: University of Washington Press, 1988), p. 252.

[43] I.H. McQuinn, 'Metapopulations and the Atlantic Herring', *Reviews in Fish Biology and Fisheries*, Vol. 7, 1997, pp. 297–329.

[44] A. Bakun, *Patterns in the Ocean: Ocean Processes and Marine Population Dynamics* (San Diego, CA: University of California Sea Grant, in cooperation with Centro de Investigaciones Biologicas de Noroeste, La Paz, Baja California Sur, Mexico, 1996).

[45] M. Heino, U. Dieckmann and O.R. Godø, 'Estimating Reaction Norms for Age and Size at Maturation with Reconstructed Immature Size Distributions: A New Technique Illustrated by Application to Northeast Arctic Cod', *ICES Journal of Marine Science*, Vol. 59, 2002, pp. 562–575; G. Ottersen, 'Pronounced Long-term Juvenation in the Spawning Stock of Arcto-Norwegian Cod (*Gadus morhua*) and Possible Consequences for Recruitment', *Canadian Journal of Fisheries and Aquatic Sciences*, Vol. 65, 2008, pp. 523–534; O.R. Godø, *Maturation Dynamics of Arcto-Norwegian Cod*, Interim Report IR-00-024, (Laxenburg: IIASA, International Institute for Applied Systems Analysis, 2000).

[46] E.M. Olsen, M. Heino, G.R. Lilly, M.J. Morgan, J. Brattey, B. Ernande and U. Dieckmann, 'Maturation Trends Indicative of Rapid Evolution Preceded the Collapse of Northern Cod', *Nature*, Vol. 428, 2004, pp. 932–935; C. Jørgensen, K. Enberg, E.S. Dunlop, R. Arlinghaus,

means that, over time, genetic composition is changing because large proportions of the stock are taken out by fishing, especially the biggest fish. We could say that fishing for the biggest fish of the stock is similar to selecting for the slaughterhouse the best bulls in a herd of livestock. Therefore the best strategies for breeding and surviving have changed. It has indeed been suggested that these life-history changes have a genetic basis; further, that they could diminish the productivity and sustainable yield of the stock because the biomass (the overall mass of the fish stock) and mean body size of fish in the population are reduced. In other words, these changes could be inherited, profoundly modifying the ecology of the species concerned. Apart from the ecological impacts of such evolution, we have to consider the associated economic costs. Within only a few decades, such evolution of life-history traits induced by fishing could significantly reduce the economic returns generated by the fishery. In addition, temperature variability has influenced the individual growth of Northeast Atlantic cod in the past,[47] and is expected to be further shaped by global climate change in the future.[48]

THE USE OF TOP PREDATORS AS INDICATORS

Ecosystems are highly complex and difficult to encompass in their totality. There is therefore a need for biological indicators which can give aggregated information on, for instance the 'health of the ecosystem'.[49] Where food-webs are relatively simple, as in the Southern Ocean, top predators such as marine mammals and seabirds may provide very useful indicators of the effects of climate.[50] For example, a decrease of as much as 10 per cent in the survival probability of king penguins (*Aptenodytes patagonicus*), which for-

---

D.S. Boukal, K. Brander, B. Ernande, A. Gardmark, F. Johnston, S. Matsumura, H. Pardoe, K. Raab, A. Silva, A. Vainikka, U. Dieckmann, M. Heino and A.D. Rijnsdorp, 'Ecology – Managing Evolving Fish Stocks', *Science*, Vol. 318, 2007, pp. 1247–1248; C.T. Marshall and H.I. Browman, 'Disentangling the Causes of Maturation Trends in Exploited Fish Populations', *Marine Ecology Progress Series*, Vol. 335, 2007, pp. 249–251.

[47] Godø, *Maturation Dynamics of Cod.*

[48] K.M. Brander, 'The Effect of Temperature on Growth of Atlantic cod (*Gadus morhua* L)', *ICES Journal of Marine Science*, Vol. 52, 1995, pp. 1–10.

[49] P. Heslenfeld and E.L. Enserink, 'OSPAR Ecological Quality Objectives: The Utility of Health Indicators for the North Sea', *ICES Journal of Marine Science*, Vol. 65, 2008, pp.1392–1397.

[50] I.L. Boyd, S. Wanless and C.J. Camphuysen (eds), *Top Predators in Marine Ecosystems: Their Role in Monitoring and Management* (Cambridge: Cambridge University Press, 2006); J.M. Durant, D.Ø. Hjermann, M. Frederiksen, J.-B. Charrassin, Y. Le Maho, P.S. Sabarros, R.J.M. Crawford and N.C. Stenseth, 'Pros and Cons of Using Seabirds as Ecological Indicators', *Climate Research*, Vol. 39, 2009, pp. 115–129.

age on fish, squid (and perhaps krill) at the edge of the Antarctic sea ice, is induced by an increase of only 0.3°C in the sea surface temperature.[51] Sea surface temperature does not affect seabirds directly: it affects the plankton and accordingly the trophic chain under a bottom–up control. The survival of king penguins is thus an indicator of the Southern Ocean 'ecosystem health' and tells us that marine systems are highly sensitive to warming. And yet, the prediction of the IPCC panel for this region was a warming of 0.4°C for the two next decades.[52]

INTEGRATION OF PHYSICAL AND BIOLOGICAL PROCESSES

Thus, to anticipate the many ecological surprises that may arise in marine ecosystems, marine ecosystems modelling needs to move toward 'end-to-end modelling'.[53] In practice, this is achieved by coupling three classes of existing models: physical models of the a-biotic environment, bio-geochemical models describing nutrient and plankton dynamics, and models describing higher trophic levels – fish, marine mammals, seabirds and fisheries.

In order to predict the possible ecosystem impacts of climate change and over-exploitation, the structure of such 'end-to-end models' should reflect the existence of major alternative food-chains. Indeed, regime shifts can be seen as the emergence of dominant food-chains, to the detriment of alternative competitive food-chains. For example, Parsons and Lalli[54] have identified large fish as being the key to high-energy food-chains. Accordingly, the over-exploitation of large fish results in the emergence of the alternative low-energy food-chains where flagellates, jellyfish and small fish dominate.

In conclusion, with global changes, new surprises are challenging our current ecological perceptions. The recent identification of the dramatic effects of basin-scale, decadal variability on marine ecosystems and component populations and species, such as small pelagic fish and salmon in the north

---

[51] C. Le Bohec, J.M. Durant, M. Gauthier-Clerc, N.C. Stenseth, Y.H. Park, R. Pradel, D. Gremillet, J.P. Gendner and Y. Le Maho, 'King Penguin Population Threatened by Southern Ocean Warming', *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 105, 2008, pp. 2493–2497.

[52] S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds), *Climate Change 2007: Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, UK and New York: Cambridge University Press).

[53] M. Travers, Y.J Shin, S. Jennings and P. Cury, 'Towards End-to-end Models for Investigating the Effects of Climate and Fishing in Marine Ecosystems', *Progress in Oceanography*, Vol. 75, 2007, pp. 751–770.

[54] T.R. Parsons and C.M. Lalli, 'Jellyfish Population Explosions: Revisiting a Hypothesis of Possible Causes', *La Mer*, Vol. 40, 2002, pp. 111–121.

Pacific, have allowed a much better comprehension of the mechanisms of physical-biological coupling. However, in most instances, these mechanisms have not yet been identified. In order to predict the interaction of marine living populations with climate change, we will need to develop a new ecosystem modelling approach in oceanography at larger to smaller spatial and temporal scales. Such an approach must take into account population, food-web and 'end-to-end models' in which exploitation by fisheries is included.[55]

[55] Cury et al., 'Ecosystem Oceanography', pp. 338–346.

8

The Polar Oceans and Climate Change

Olav Orheim

SCOPE AND DATA EVALUATION

The following discussion considers the climate changes that have taken place – and are expected – for the polar oceans. It is based on two recent comprehensive climate reviews, *Arctic Climate Impact Assessment*[1] presented in 2005, and *Antarctic Climate Change and the Environment*,[2] produced by the Scientific Committee on Antarctic Research in 2009.

The word 'climate' is here used broadly to cover all aspects of the physical earth system that relate to the atmosphere and the ocean, and to water in liquid, gaseous or frozen form. Given the theme of this volume, I focus especially on climate as it relates to the Arctic Ocean and the Southern Ocean. In particular I try to give an overview of the climate changes now taking place, as well as those modelled for the future, which affect the conditions for existence and for operations in the polar oceans and along their coasts.

The polar regions have been relatively little studied until recently, due to difficult accessibility and lack of local transport. This means that there are few long-term climate records based on human observations. South of 60°S, only one record extends much beyond 50 years, as there was little human presence in the Antarctic prior to the International Geophysical Year in 1957/58. In the Arctic some human-based records are longer, but only from a few places, as the population is sparsely distributed. There are few dense observation networks on land in the Arctic, none in the Antarctic, and none in the Arctic Ocean or the Southern Ocean.

[1] *Arctic Climate Impact Assessment* (Cambridge University Press, 2006).

[2] J. Turner, R.A. Bindschadler, P. Convey, G. Prisco, E. Fahrbach, J. Gutt, D.A. Hodgson, P.A. Mayewski and C.P. Summerhayes (eds), *Antarctic Climate Change and the Environment* (Cambridge: Scientific Committee on Antarctic Research, 2009).

In addition to the observation records there are of course numerous palaeo-climatic records. However, many of these employ a coarse time-resolution, making them less valuable for predicting climate change on human time-scales.

This lack of good data coverage in time and space indicates that caution should be exercised in interpreting records of climate change and predicting future climate. Nevertheless, there are patterns now appearing which can be used as a basis for conclusions on present and past climate changes – thanks not least to the results from the International Polar Year (IPY), with its concentrated field-research period from 1 March 2007 until 1 March 2009.

CLIMATE CHANGE IN THE ARCTIC, WITH FOCUS ON THE ARCTIC OCEAN

Changes in Temperature

Proxy data from ice cores, marine sediments and other sources show that the Arctic climate has undergone large variation, on time-scales ranging from millennia to mere decades. Surface temperature observations and other records reveal that in recent decades the climate is clearly becoming warmer, with warming of the ocean water masses as well as of surface atmosphere near the land surface, especially in winter. The whole Arctic is now undergoing significant warming, typically at a rate of 0.4°C per decade, with the greatest increases observed on land in parts of northern Canada and Siberia.[3] Models predict that the rate will increase in the future; indeed, they indicate that the Arctic will be the region on earth which will show the most pronounced temperature increase during this century, at two to three times the global average. There are several reasons for such model results, including the feedback effect of changes in surface reflectivity (albedo), which is a major element. Absorption of solar radiation can increase tenfold when a surface changes from dry white snow to bare land or water.

The ongoing warming is now thawing the permafrost, with consequential failure of land-based structures that have their foundations in the subsiding soil. Both the melting of the permafrost, and increased wave action because of longer periods of ice-free waters near the coasts, are reasons for increased coastal erosion. In this way, climate changes are affecting local harbours and coastal settlements.

The Arctic Ocean is the name given to the ocean north of the land masses of Eurasia, North America and Greenland. It covers an area of about 14 mil-

[3] *Arctic Climate Impact Assessment.*

lion square km, and consists of the central Arctic Ocean, which lies north of any islands, and the bordering water masses of the Barents, White, Kara, Laptev, East Siberian, Chukchi and Beaufort Seas, Baffin Bay, and the Greenland Sea (reckoned anti-clockwise from the Norwegian coast). Sometimes also Hudson Bay is included in the term. The Arctic Ocean is connected to the Pacific by the Bering Strait and to the Atlantic through the Greenland and Labrador Seas, with main exchanges of ocean-water masses taking place through the Fram Strait between Greenland and the island of Spitsbergen. The Arctic Ocean is about 1½ times larger than the land-mass of Europe in area.

Changes in Sea Ice

Until recently by far the largest part of the Arctic Ocean was covered by sea ice most of the year. This situation has changed dramatically in recent years – and the reduction in sea ice is now perhaps the strongest global signal of on-going climate change. The shift from sea ice to water is the main cause of the temperature change.[4] Replacing ice with open water in winter leads to much warmer winter temperatures.

Major seasonal variations in the extent of Arctic sea ice are significant; the extent is decreasing markedly over the 32 years of useful satellite observations. Deviation from the mean is particularly strong after 2003: indeed, since early 2003 there has not been a single day when the extent of Arctic sea ice has reached the 1978–2000 mean.[5]

The decrease in extent is the best-documented change of the Arctic sea ice. However, a variety of data have now unequivocally demonstrated that also the thickness of that ice has decreased significantly. Such data are based on submarine observations dating back to the middle of the past century, on direct thickness measurements, and on remote sensing from flying over the ice. Although the observations are not dense, they indicate an almost halving of ice thickness in recent decades.

Concomitantly, the age of the sea ice has been decreasing, as shown by ice data.[6] In the 1980s, more than half the ice in the Arctic Ocean was two years old or more; the corresponding figure was only about 10 per cent less during the years up to 2007. The next three years saw a dramatic change: by 2010 only 15 per cent of the ocean was covered by two-year ice. Corres-

[4] Ibid.

[5] For further information and illustrations on the northern hemisphere sea ice area, see <http://arctic.atmos.uiuc.edu/cryosphere/IMAGES/current.area.jpg>, and on the northern hemisphere sea ice anomaly see <http://arctic.atmos.uiuc.edu/cryosphere/IMAGES/current.anom.jpg>.

[6] Available at <http://nsidc.org/>.

pondingly, the area covered by first-year ice has increased and now exceeds 50 per cent.

For Arctic operations this represents a very significant development. There are literally thousands of merchant vessels that are designed to go in thin, first-year ice, whereas almost none can travel safely in what used to be thick multiyear ice. If the current evolution continues, then not only will there be ice-free periods that the commercial ships can travel in: there will also be a period in the autumn when they can operate in familiar fashion in the predictable thin ice.

Changes in Ocean Temperature and Salinity, and Effects of Acidification

The few long-term records of sea temperatures within the Arctic Ocean do not give any strong signals. Some areas showed a marked ocean warming up to 2007, while temperatures thereafter have gone down slightly.[7] In general the upper ocean shows considerable year-to-year variability, with no significant trends.

The increased melting of sea ice has led to a freshening of the surface-layer waters of the Arctic Ocean. The ocean acidification caused by increased CO_2 uptake is making some surface waters corrosive to calcifying organisms, with potentially great effects on the whole food-chain. As yet, however, it is not possible to predict the long-term effects of such acidification on the ecosystem of the Arctic Ocean.

Other Changes: Precipitation and in Wind

There are few reliable measurement series of precipitation in the Arctic, not least due to the practical difficulties of measuring snowfall. There is some evidence of increased precipitation in the North American High Arctic, but we have no firm information on precipitation changes over the Arctic Ocean. There is no clear evidence of changes in wind pattern and strength.

Icebergs

The major sources of icebergs entering the central Arctic Ocean are glaciers located in North Greenland, Ellesmere Island and Severnaya Zemlya. Icebergs are also produced from glaciers in Novaya Zemlya, Franz Josef Land and Svalbard, but most of these icebergs enter the Barents Sea. Icebergs from north-facing glaciers of the two latter island groups are usually rapidly

[7] *Arctic Climate Impact Assessment.*

exported out of the central Arctic Ocean through the Fram Strait between Greenland and Svalbard. Paradoxically, icebergs are therefore scarce in the central Arctic Ocean, even though icebergs in these cold waters experience low melting rates. There seems to be no discernible trend in iceberg production for the central Arctic Ocean.

There are a great many more icebergs in Baffin Bay, originating from calving glaciers on the west side of Greenland. Since the 1990s, some of the outlet glaciers of the Greenland ice sheet have shown large increases in velocity, with associated increases in iceberg calving rates. All these icebergs eventually follow the ocean currents southwards along Newfoundland and are here exported into the North Atlantic – as happened with the iceberg hit by the *Titanic* nearly 100 years ago. The icebergs produced at the east coast of Greenland travel first southwards along the coast in the strong current from the Fram Strait; thereafter they, too, tend to end up on the Grand Banks off Newfoundland.

Icing

There are no data to indicate that any change in the frequency of conditions that favour icing, which is the name given to the phenomenon when cold sea spray freezes on structures. It typically takes place when high winds, open seas and sub-freezing temperatures combine, and can cause floating structures to become unstable and topple over. Icing is a major potential danger to increased ship operations in the Arctic.

With decreasing sea ice, the periods of open water in combination with high winds are likely to increase, and thus also the potential for icing conditions. Reliable weather forecasts will therefore be an important tool for improved safety of operations in the Arctic Ocean.

CLIMATE CHANGE IN THE ANTARCTIC, WITH A FOCUS ON THE SOUTHERN OCEAN

Discussing the climate changes observed for the waters around the Antarctic continent is a simpler task than for the Arctic Ocean, even though the area of freezing conditions and cold waters is much larger. This is simply because we have so much less data, and thus can generally not draw conclusions that apply to larger parts of the continent or the surrounding ocean.

Some geographical authorities do not consider the waters around Antarctica as anything but the southern continuation of the Pacific, Atlantic and Indian Oceans. Thus the International Hydrographic Organization (IHO) publication 'Limits of Oceans and Seas' did not define a 'Southern Ocean'

in its third edition.[8] However, the fourth edition defined, in 2000, the Southern Ocean to be the ocean south of 60°S,[9] but this definition has not yet been ratified. IHO also took the position that this ocean should be called the Southern Ocean, rather than the Antarctic Ocean. I will follow that practice here.

The IHO definition uses the same boundary as the Antarctic Treaty, i.e. the oceans south of 60°S. However, that is not a boundary which coincides with any physical phenomena. So it is more usual to take as the northern boundary the Antarctic Convergence, which is the name given to the zone where the cold Antarctic waters meet the warmer oceans to the north. However, that boundary shifts with the seasons. To avoid operating with moving boundaries in a legal regime, the Convention for the Conservation of Antarctic Marine Living Resources (CAMLR Convention) has defined its area of application as all waters bounded by the Antarctic Continent to the south, and to the north by a line starting at 50°S, 50°W; thence due east to 30°E longitude; thence due north to 45°S latitude; thence due east to 80°E longitude; thence due south to 55°S latitude; thence due east to 150°E longitude; thence due south to 60°S latitude; thence due east to 50°W longitude; and finally due north to the starting point.[10]

Using the IHO definition, the Southern Ocean covers an area of 20 million square km, so the Southern Ocean is much larger than its Arctic counterpart, even when the most restrictive definition is applied. It is not covered by observation series, which makes it difficult to detect climate changes with confidence, especially because of the intense seasonal cycle. There are also decadal and regional changes which may mask long-term trends. Only around South Georgia are there enough observations to establish a trend. Here there has been a warming of 2.3°C over 81 years in the upper 150 m, with the in winter temperatures being most pronounced.[11]

The Antarctic Circumpolar Current shows warming and freshening over the past four decades, consistent with a southward shift of the current.[12]

---

[8] International Hydrographic Organization, *Limits of Oceans and Seas, Special Publication No. 28*, 3rd edition (Monte-Carlo: Monégasque, 1953).

[9] A fourth draft edition of IMO's *Limits of Oceans and Seas* was proposed but has yet to be ratified.

[10] On the CAMLR Convention area and the 'Antarctic Convergence', see also discussion by D.G.M. Miller, N. Slicer and E.N. Sabourenkov, 'IUU Fishing in Antarctic Waters: CCAMLR Actions and Regulations', in D. Vidas (ed.), *Law, Technology and Science for Oceans in Globalisation* (Leiden: Martinus Nijhoff, 2010), pp. 175–196, especially at pp. 176–177, where also a map illustration is provided.

[11] Turner et al., *Antarctic Climate Change and the Environment.*

[12] Ibid.

Sea Ice

There are no reliable records of sea-ice extent in the Southern Ocean for periods before the satellite observations. Attempts have been made to indirectly determine extent of sea ice/open water around the continent by analysing inland ice cores for chemical substances that can be proxies for distance to open water. However, the extent of such deposits on the ice sheet also depends upon wind direction and strength. Tracks of whaling ships have also been analysed to determine the sea-ice edge indirectly, but again decisions on where these ships went were also related to many other factors, including the weather and personal decisions by the captains on what they perceived as the most likely good hunting grounds.

Satellite observations show that, unlike the case of the Arctic record, there are no strong trends at all in changes in sea ice in the Southern Ocean.[13] The time variations in sea-ice extent are much more pronounced in the Southern Hemisphere, and if there is a systematic change at all it is mostly masked by the large short-term variations. Possibly there has been a very small increase over time.

Satellite observations also show that the seasonal variation in sea-ice extent is greater in the Southern Ocean, and that most of the winter sea ice has melted away. Only in the Weddell Sea are there large expanses of ice that survive the summer. The extent of sea ice in the Southern Ocean each winter is to a considerable part a function of wind strength. The strongest freezing of the sea ice takes place along the coasts, and the ice is then blown northwards by offshore winds. Thus, year-to-year variations in the extent of sea ice may be more a reflection of wind strength than of any changes in temperature conditions.

With regard to the changes in temperature over Antarctica and the Southern Ocean, it should also be noted that recent research has shown that the ozone 'hole' over Antarctica has been counteracting any effects of global warming. At present only the Antarctic Peninsula exhibits strong warming, whereas it is not clear whether the atmosphere over main part of the ice sheet is undergoing any temperature change.

[13] Variation in the sea ice area in the Southern Ocean from 1978 to 2011 is available at <http://arctic.atmos.uiuc.edu/cryosphere/IMAGES/current.area.south.jpg>. Deviation in sea-ice area from the 1978–2000 average, for every day from 1978 to January 2011 is available at <http://arctic.atmos.uiuc.edu/cryosphere/IMAGES/current.anom.south.jpg>.

GLOBAL SEA LEVEL

Sea level is currently rising at an average rate of 3 mm/year. The most recent prediction by the International Panel on Climate Change of change by the end of the 21st century is 0.5 m, plus the contributions from the Greenland and Antarctic ice sheets. Recent research, especially from satellite observation over the past few years, and from intense measurements conducted during IPY, have demonstrated that the water masses added to the world ocean from the continental ice sheets are greater than previously predicted by most models, and that the contribution to sea level rise from these two ice sheets now exceeds that from other small glaciers.[14] From such results it can be estimated that a sea-level increase of 1.4 m during the present century is most likely. That would be of such a magnitude as to affect many physical structures, and planning would need to take account of such a change.[15]

On the other hand, it is also becoming clear that the rise in sea level will not be uniform around the globe, and that there will be deviations from this mean figure on the metre-level. Local planning must therefore take into account such geographic variations as well.

[14] E. Rignot, I. Velicogna, M.R. van den Broeke, A. Monaghan and J. Lenaerts, 'Acceleration of the Contribution of the Greenland and Antarctic Ice Sheets to Sea Level Rise', *Geophysical Research Letters*, Vol. 38, 2011, LO5503.

[15] As to legal consequences under international law of the sea, see Hayashi, chapter 11 in this book.

9

Climate Change and Arctic Governance: Three Images of a Changing Arctic

David D. Caron[*]

The contributions in this book focus on the challenges that globalisation poses for marine regions. This chapter does so in terms of the Arctic. Let me begin by explaining how I understand the theme. What are 'globalisation' and a 'marine region' – and what are the challenges? 'Globalisation' is a term widely used yet somewhat elusive to define. But at a minimum globalisation is, at least in the case of fisheries, a phenomenon in production and consumption that changes the regime of fishing in any region. A 'region' in turn is not simply any area of the globe – this was a lesson learned by UNEP in its regional seas programme. A region is also to some extent a community of states and of people. In this view of globalisation and regions, the 'challenges' are twofold. First, how do the nations of a region and the region itself respond to the demands of globalisation? And second, does globalisation necessitate a shift from regional governance to global governance?

In terms of the theme of this volume, the Arctic is indeed special. The theme appears to presume that a pre-existing region is challenged by the demands of globalisation. There is a double challenge in the case of the Arctic, where the area seeks to form itself as a region even as it is being challenged by the demands of globalisation. The Arctic is unique among marine regions in that it is feeling the demands of globalisation simultaneously with its emergence as a region. In looking at the Arctic within this theme and with the special case of the Arctic in mind, this chapter argues two points. First, discussions of the Arctic can be understood in terms of

[*] I thank my colleagues Harry N. Scheiber and Thomas Barnes for their comments and encouragement on this article. I also thank the Berkeley Law of the Sea Institute for its support.

three images – and each of these images tells us something about the Arctic as a region. Second, the circumpolar states will face substantial challenges in attempting to govern the future of the Arctic.

THE IMAGES

There are many conferences and much news today about the Arctic and its future. As I see it, the views expressed can be like ships passing in the dark – they come from different directions, go different places, and are concerned with themselves and somewhat unaware of the others. Needless to say this can be confusing, if not dissatisfying, for audiences. Over the years, I have observed that thoughts about the politics and law of the Arctic are animated by some image of the Arctic – and that these images can then tell us something about the Arctic as a region.

The First Image – The Impassable Area

The first image of the Arctic is the one that has dominated our vision for centuries and which, it is important to recognise, will persist to a significant degree, for reasons I discuss later. This image is in black and white. Pack ice – apparently empty of life, extends to the distant horizon beneath a slate-grey sky. In this image the Arctic is inhospitable and impassable. Here, the threat that the USSR and the USA posed for each other during the Cold War was not that the forces of the other side would come across the ice, but rather that their missiles would come over the ice. Here one does not think of crossing the Arctic Ocean – but rather of heroic explorers reaching the North Pole, only to return quickly.[1] It was only in 1908 that Robert Perry, along with Mathew Henson and four Eskimos, were the first people to reach the North Pole. Not until in 1926 did Amundsen and then Byrd become the first to fly over the North Pole. I sailed to the Arctic as navigator and ship salvage diving officer aboard the USCGC *Polar Star* in June of 1976 and, even then, we met the seasonal ice of the Arctic south of the Bering Straits and the permanent pack ice just north of Alaska; even then, no American surface vessel had broken ice through to the North Pole.

In this image, both law and politics are dormant. As a noted Canadian scholar of the region, Douglas Johnston, wrote in 1970, '[t]he Arctic is largely hypothetical'.[2] Boundaries with neighbours are sketchy and unclear,

[1] For the account of a much-debated 'dash' in 1908 to the North Pole, see F.A. Cook, *Return from the Pole* (New York: Pellegrini and Cudahy, 1951).

[2] D. Johnston, 'Canada's Arctic Marine Environment: Problems of Legal Protection', *Behind the Headlines*, Vol. 29, 14 July 1970, p. 1.

but there is no urgency to resolving them. In general, the citizens of the circumpolar states live in more southern regions, and if the native peoples who do live in the North wish to move about as if these unclear boundaries did not exist at all, there is little harm in their doing so. It may very well be that valuable resources exist in the region, but their exploitation, like the exploitation of the manganese nodules of the deep seabed, may not be technically possible and, even if possible, do not yet make commercial sense. It may be possible to refer to an 'Arctic region', and it certainly is a region for the indigenous peoples who populate the rim of the Arctic. But in another sense it is a region delineated more by its absence rather than by its presence. 'There simply have been insufficient incentives to trigger the development of answers to such questions; the severe environment has kept any significant presence out of the area.'[3]

This image is almost gone now – but it not entirely, nor will it ever disappear completely. It may be that climate change will warm the Earth's atmosphere sufficiently to reduce ice coverage, but that will not alter the angle of the Earth. The first image remains a strong image of the Arctic in the winter season. The Arctic may be getting warmer and more ice-free in summer, but it remains no less dark throughout the winter. The winter ice may become annual, rather than perennial, ice coverage and therefore not as formidable, but it will not disappear. Indeed, one estimate is that it would take an average 30°C rise in temperature globally to render the Arctic ice-free in winter.[4] Recognition of the persistence of winter is crucial, because the warmer visions found in the second and third images must be seen in seasonal terms. Shipping routes will be used for only certain months of the year, not the entire year, and there may be transition periods where the risks of such use increase. Likewise, the anticipated expansion of offshore oil and gas activities must be seen in terms of the ability of such structures to withstand the structural demands of the winter season. The remnant of the image of the Arctic as an inhospitable place is one that calls for caution. In this sense, I feel, the calls made by many for the development of safety infrastructure in the Arctic are a critical point.[5]

---

[3] B.D. Smith, 'Canadian and Soviet Arctic Policy: An Icy Reception for the Law of the Sea?', *Virginia Journal of International Law*, Vol. 16, 1976, at p. 609.

[4] See, e.g., A. Ananthaswamy, 'Once the South Pole Was Green…', *New Scientist*, 21 June 2008, p. 37: when the poles were green approximately 100 to 40 million years ago, average mean temperatures in tropics may have been as high as 40° to 50° C.

[5] See, e.g., Brigham, chapter 18 in this book, on the challenges facing shipping.

The Second Image – The Ring

The second image is that of the composite photograph depicting the extent to which summer ice has retreated in recent years. Here the centre of the Arctic remains impassable to all but icebreakers. And even for icebreakers such passages take time, consume fuel, and involve some risk. But although the centre remains impassable, there is now a ring of water around the Arctic Ocean. In contrast to the impassable sense of the first image, we now can see the possibility of following the coastline, skirting the land on one side and the ice on the other.

In this image, both law and politics involve 'proximate bilateralism'. In this image, each Arctic state focuses on its portion of the ring and in turn focuses on its borders with its immediate neighbours. It is in this sense of a focus on one's *immediate* neighbours that I say this image involves not only the bilateral, but emphasises *proximate* bilateralism.

Each coastal asks what value – what oil or gas, what fish – is in its portion of the accessible ring.[6] And quite immediately, each Arctic state becomes more concerned with the location of its borders with its neighbours, in order to understand what belongs to it. The Canadians and the Danes discuss Hans Island and the Lincoln Sea.[7] Canada and the United States discuss a line in the Beaufort Sea, while the United States and Russia discuss the line above the Bering Strait. Russia and Norway look at a part of the ring that has been accessible for a long time, the Barents Sea, and seek to refine the line between them and to further their separate uses of the area.[8] Shared navigational use of the ring becomes an issue between neighbours (and to a lesser extent for states outside of the Arctic region). As the Northwest Passage opens up, the recurring discussion between Canada and the United States takes on a new sense of seriousness.[9] For Russia, whose coastline encompasses almost all of the Northern Sea Route, the previously limited Russian practice regarding the right of such passage is examined more closely.[10]

---

[6] Q. Wong, 'Study Estimates Vast Supplies of Arctic Oil and Gas', *Anchorage Daily News*, 24 July 2008, at p. A6.

[7] See C. Stevenson, 'Hands Off! The Struggle for Hans Island and the Potential Ramifications for International Border Dispute Resolution', *Boston College International and Comparative Law Review*, Vol. 30, 2007, pp. 263–275.

[8] On the agreement signed by Norway and Russia on 15 September 2010, see Ø. Jensen, 'The Barents Sea: Treaty between Norway and the Russian Federation concerning Maritime Delimitation and Cooperation in the Barents Sea and the Arctic Ocean', IJMCL, Vol. 26, 2011, pp. 151–168.

[9] On the renewed focus on the Northwest Passage, see, e.g., J. Kraska, 'The Law of the Sea Convention and the Northwest Passage', IJMCL, Vol. 22, 2007, pp. 257–282.

[10] L. Tymchenko, 'The Northern Sea Route: Russian Management and Jurisdiction over Naviga-

Fundamentally, this image is nationalistic and inward-looking. States look outward – but only to understand what is within. In this image there is an emerging Arctic region, but more properly it should be thought of as two emerging Arctic arcs: that along the Northwest Passage, and that along the Northern Sea Route.

The Third Image – The Semi-Enclosed Ocean

The third image is an image of the Arctic in the not too distant future, by 2030 or perhaps as early as 2015.[11] For the first time, there is no summer ice. The image is of a semi-enclosed ocean. And here we should bear in mind that this semi-enclosed ocean is five times larger than the Mediterranean. Likewise, it is important to appreciate that even if the seabed of the Arctic has been substantially divided up between the circumpolar states, a significant part of the superjacent waters of the Arctic Ocean will remain high seas.

This image leads to two significant shifts from the second image. First, one looks not only to one's neighbours so as to define oneself: one also looks outward across the sea, as each state recognises that it is an inseparable part of the larger arctic region (and here the word 'region' is used in its full sense).

Second, like all semi-enclosed areas, the states inside will become concerned with the states outside the sea entirely, and the states outside will become increasingly interested in asserting their interests in the semi-enclosed ocean. Because of both of these shifts, in the third image, law and politics are concerned with governance of a shared area.

In the third image, many of the coastal development projects viewed as possible in the second image have now come about. There are many more people in the Arctic and significantly more activity. The emphasis in the second image, of drawing jurisdictional lines between neighbours along the

---

tion in Arctic Seas', in A. Oude Elferink and D. Rothwell (eds), *The Law of the Sea and Polar Maritime Delimitation and Jurisdiction* (The Hague: Martinus Nijhoff, 2001), pp. 269–291.

[11] Projections of the retreat of ice coverage in the Arctic have been revised several times as the observed retreat has exceeded projections. See, e.g., A. Revkin, 'Arctic Sea Ice Melting Faster, A Study Finds', *New York Times*, 1 May 2007, at p. A5; 'Arctic Ice Continues to Thin', *New Scientist*, 2 August 2008 (noting a German study finding that the summer ice at the end of the summer of 2007 had an average thickness of 1.3 meters whereas the average had been 2.3 meters in 2001 and 2.6 meters in 2004): based on C. Haas, A. Pfaffling, S. Hendricks, L. Rabenstein, J.-L. Etienne and I. Rigor, 'Reduced Ice Thickness in Arctic Transpolar Drift Favors Rapid Ice Retreat', *Geophysical Research Letters*, Vol. 35, 2008. In part, these revisions reflect a continuing refinement of our understanding of the warming mechanisms at play in the arctic region and globe generally; see, e.g., C. Brahic, 'Is the Arctic Helping to Warm the World?', *New Scientist*, 26 April 2008, p. 12, noting unanticipated changes in both water and air circulation patterns.

ring, increasingly adds and gradually shifts to the drawing of jurisdictional lines into the centre of the Arctic Ocean, particularly on the seabed.[12] Likewise, there is a shift from the drawing of jurisdictional lines along the ring to an emphasis on governance of a shared area, the semi-enclosed ocean.

The Influence of the Three Images

The influence of each of these images on law and politics is changing as a result of warming in the Arctic and the social and economic consequences of that warming. It is important to bear in mind that, depending upon one's position, these three images exist simultaneously in many discussions. The general effect of warming is to give more influence to the issues present in the second and third images, and in essence to accelerate our moving from the first toward the third image.

THE DIFFICULTY OF REGIONAL ARCTIC GOVERNANCE

If the challenge is governance, then the critically important point is that successful governance of the Arctic is heavily dependent on Russia. It is often said that the policy choices of the United States, China and India are central to the question of climate change. So too will it be the choices of Russia that are central to the future of the Arctic. The Arctic as a semi-enclosed ocean is dominated in terms of coastline by Russia and by Canada. And between the two of them, it is quickly apparent that in terms of population, economic activity, and watersheds emptying into the Arctic Ocean, it is Russia that is most 'present' in the Arctic. That fact is problematic in that the possibilities of successful shared governance are highly dependent on the regulatory capacities of the states involved. And in this regard, the reality on the ground is that the Russian regulatory state is still a work in progress – a circumstance that is probably even greater in the Russian hinterland. This circumstance is further complicated by the distribution of power in the Arctic. States have different levels and types of power. Sometimes bases of power are legally conferred. One legally enshrined source of power in the Arctic is

[12] The claims of the circumpolar states to the seabed of the Arctic are complicated by the realities of the seabed and the recognition in the 1982 UN Convention on the Law of the Sea that a coastal state's claim to the (legal) continental shelf can extend further than 200 nautical miles if the shelf itself extends further. Thus ocean surveys of the Arctic seabed are in hot demand as the second image shifts towards the third. On the continental shelf beyond 200 nautical miles, see Part V in D. Vidas (ed.), *Law, Technology and Science for Oceans in Globalisation* (Leiden: Martinus Nijhoff, 2010), pp. 423–589.

the amount of ocean areas controlled by the adjacent state is dependent on the length of that state's coastline. The United States is a powerful state with only a small percentage of the coastline of the Arctic. Canada has a long coastline but relatively less power as a state. Russia has both the longest coastline of any state in the Arctic and significant power as a state. As Mikhaylichenko observes: 'Russia's Arctic zone embraces almost one half of the Earth's circumference in these latitudes'.[13]

Given these differences and the centrality of Russia, how are the five different Arctic states to work together when it comes to regional governance? The main institutional effort at Arctic governance at present is the Arctic Council.[14] But although the Council has an innovative structure and has produced important studies in its short existence, it is also an institution of limited capacities, with certain issues beyond its mandate. It is important to note, for example, that the extensive and highly problematic nuclear wastes dumped in the Kara and White Seas are not discussed at the Arctic Council.

Over the past few years, several scholars, warning of a looming land rush in the Arctic, have called for a comprehensive 'Arctic Treaty', often making comparisons to the treaty governing Antarctica.[15] Others see the analogy to Antarctica as misplaced and the call for a comprehensive treaty likewise misplaced.[16] Yet others regard the 1982 UN Convention on the Law of the

---

[13] For a valuable presentation of the Russian perspective on the Arctic, see Y.G. Mikhaylichenko, 'The Arctic Ocean', in H.D. Smith (ed.), *The Oceans: Key Issues in Marine Affairs* (Heidelberg: Springer, 2004), pp. 283–296.

[14] For details on the Arctic Council see <http://arctic-council.org/section/the_arctic_council>. *See also* T. Koivurova and D.L. VanderZwaag, 'The Arctic Council at 10 Years: Retrospect and Prospects', *University of British Columbia Law Review*, Vol. 40, 2007, pp. 121–194. For a historical perspective, see D. Pharand, "The Case for an Arctic Region Council and a Treaty Proposal', *Revue générale de droit*, Vol. 23, 1992, pp. 1110–1124; D.D. Caron, 'Towards an Arctic Environmental Regime', ODIL, 1993, pp. 377–392; and D.D. Caron, 'Initiatives Affecting Ocean Governance in the Arctic', in D.D. Caron, C. Carr and H.N. Scheiber (eds), *Challenges and Issues in Ocean Governance* (Ocean Governance Study Group, 1993), pp. 31–40.

[15] See, e.g., S.G. Borgenson, 'Arctic Meltdown: The Economic and Security Implications of Global Warming', *Foreign Affairs*, Vol. 87, March/April 2008, p. 63. See also S. Holmes, 'Breaking the Ice: Emerging Legal Issues in Arctic Sovereignty', Chicago Journal of International Law, Vol. 9, 2008, at p. 323, arguing that the Antarctic Treaty could serve as a loose model; and D. Rothwell, 'The Arctic in International Affairs: Time for a New Regime?', *ANU College of Law Research Paper* No. 08-37, 2008, especially pp. 12–13: 'could the Antarctic model be a useful way forward for the Arctic? There is in principle nothing to stop the Arctic States from looking towards an Antarctic Treaty-type model for the Arctic region… Such a Treaty would, however, only be a starting point. There would inevitably be a need for additional protocols to address specific issues such as navigation and shipping, seabed resource management, marine environmental protection, and the rights and interests of indigenous peoples'.

[16] See, e.g., Legal Adviser of the US Department of State, J.B. Bellinger, 'Treaty on Ice', *New*

Sea as providing a comprehensive regime for high-seas commons in the Arctic, and call on the USA to ratify that treaty.[17]

In addition, as indicated by the second shift that accompanies the third image, we may expect that the states of the rest of the globe will become increasingly interested in the Arctic. In particular, in the third image, there can be little doubt that the fishing fleets of East Asia and Northern Europe will gradually begin to operate on the Arctic high seas, perhaps in significant numbers. (Recall also that fish are particularly sensitive to water temperatures and have already been observed to be moving northward.) Again governance will become important. At a minimum, we will see, for example, the creation of one or more regional fisheries organisations in the Arctic. And as regional efforts at governance advance, we can expect that states outside the region will ask why the Arctic Ocean should be the province of a handful of states, and will seek to globalise such efforts at governance, at least for those areas beyond national jurisdiction.

Finally, we must acknowledge that cooperative governance as a historical matter is not to be assumed. In particular, in the third image there arises a possibility that was impossible in the first image: the militarisation of the surface of the Arctic Ocean. Is it so far-fetched to imagine the symbolic entry of a convoy of destroyers by 2020, or of an aircraft carrier by 2030? In one sense this might be seen as merely a symbolic militarisation, given the operation of submarines under the Northern ice for many decades. But symbols often matter. Again, at some point, this surface presence will include the military vessels of non-circumpolar nations. Even if unlikely, a general agenda item, perhaps better thought of now rather than later, is the regional demilitarisation of at least the surface waters of the Arctic Ocean.

York Times, 23 June 2008, at p. A21, who argues that although '[s]ome nongovernmental organizations and academics say that we need an 'Arctic treaty' along the lines of the treaty system that governs Antarctica … such a treaty would be unnecessary and inappropriate'.

[17] Scholars and politicians alike have pointed to the changing situation in the Arctic as demanding US ratification of the LOS Convention; see, e.g., B.G. Sobel, I. Smith and A. Rosencranz, 'The Melting and Partitioning of a Global Commons', *Environmental Policy and Law*, Vol. 37, 2007, pp. 467–470. As is often the case, there also was a crossover between second-image and third-image argumentation. Even as some called for the ratification of the LOS Convention to provide a regime for the high-seas commons in the Arctic, others pointed to the need for the USA to ratify the Convention, so that the USA might make its own extended claims to the continental shelf; see, e.g., D. Moe, 'US Should Follow Law of the Sea' (Letter to the Editor), *Juneau Empire*, 14 April 2009 (arguing that by 'refusing to sign this treaty, the United States is once again going to be on the outside looking in, while the other countries take control of the Arctic Ocean').

CONCLUSION

The changing Arctic presents a wide range of issues, and the ongoing discussions can often talk past each other. Each of the three images of the Arctic described above is important to addressing the Arctic's future. If the prime driver of interest in the Arctic is resource exploitation, then we can rest assured that there will be much discussion in the second image. It is the third image that raises important questions of the national, regional and global governance of the region that we will need to incorporate into the discussions to come.

10

The Climate Regime: Achievements and Challenges

Steinar Andresen and Tora Skodvin

As a scientific issue, climate change has been on the agenda for more than 50 years; it reached the international political agenda more than 20 years ago. Against this background, the goal of this chapter is threefold: to assess what has been achieved; explore main factors that have contributed to this outcome; and briefly discuss future developments. The main components of the climate regime are the 1992 United Nations Framework Convention on Climate Change (UNFCCC),[1] the Kyoto Protocol and the Intergovernmental Panel on Climate Change (IPCC). The Copenhagen Accord of 2009 and the Cancun Agreement of 2010 will also be briefly touched upon. Considering the long time-span, our aim is to trace broad patterns and trends.

From 2005 and until the financial crisis in the autumn of 2008, the environment, and climate change in particular, was at the top of the international political agenda. It had become 'high politics': 'overall there is hardly any high-level political encounter in which the issue is not discussed'.[2] One main reason for the strong surge in interest was probably the perceived, and rather dramatic, visualisation of the problem with stronger and more frequent tropical storms, shrinking glaciers and pictures of polar bears looking for ice. These images were amplified by the stronger and more consensual IPCC reports released in 2007. In addition, the long period of unprecedented economic growth worldwide created fertile ground for dealing with long-term issues like climate change. This was to change with the economic crisis, and put its mark on COP 15 in Copenhagen.

[1] Text published in UNTS, Vol. 1771, pp. 164ff; reprinted in ILM, Vol. 31, 1992, pp. 849ff.

[2] S. Oberthur and C.R. Kelly, 'EU Leadership in International Climate Policy: Achievements and Challenges', *The International Spectator*, Vol. 43, 2008, p. 35.

In the next section we outline briefly the development of the climate regime. We then present our analytical perspective and thereafter discuss the effectiveness of the regime and point to some main factors that have contributed to its performance. In the final section we discuss possible future developments.

THE DEVELOPMENT OF THE CLIMATE REGIME

The Agenda-setting Phase

Although the influence of increased concentrations of greenhouse gases (GHGs) on the earth's climate was the subject of sporadic scientific interest during the 19th century, it was not until the 1950s that it was embedded within systematic research programmes, not least through the International Geophysical Year 1957–1958. Most research in this early phase was undertaken in the USA. Then, in the 1960s and 1970s, climate research was fostered by several overlapping transnational scientific networks under the aegis of the World Meteorological Organization (WMO) and the International Council of Scientific Unions (ICSU). In the 1970s the policy relevance of climate change was sharpened by the United Nations Environment Programme (UNEP), which pointed to the societal impacts of climate variability. Politically, the USA was also the first to take an interest in the issue, not least as a result of initiatives by Al Gore, then a young Congressman, who arranged the first Congressional hearings on climate change in 1982. Initially, the scientific focus was mostly on the effects of CO_2 emissions on the climate system. At a 1985 expert conference in Villach, Austria, however, it was concluded that climate change might be twice as urgent as originally thought because of the additional warming influence of other GHGs. The final milestone in the agenda-setting phase was the Toronto World Conference on the Changing Atmosphere in 1988. By this time, the green NGOs had entered the scene with full force, further sharpening the findings by the scientific community. The Toronto Conference proved to be forceful combination of activist scientists, activist politicians and green NGOs. The Conference coincided with an unusually hot summer in the USA, and NASA scientist James Hansen had made headlines with his statements in Congress that he was 99 per cent certain that the high summer temperatures were indicative of real warming trends. This set the stage for a political atmosphere charged with high ambitions, and the Toronto Conference called for the industrialised countries to cut their CO_2 emissions by 20 per cent by 2005. That was an overly optimistic target, and reflected inadequate understanding of the complexities and difficulties involved. The Toronto Conference was

nevertheless very important in terms of how to approach the issue of climate change.[3]

The Process of Negotiations

A key decision taken shortly after the Toronto Conference with significant implications for the formation of the climate regime was the establishment of the IPCC. The mandate of the Panel was to assess the state of knowledge on science, the impacts of and policy responses to climate change. It was established around a small group of reputed experts, and has since expanded to include hundreds of scientists. The Panel was intergovernmental, introducing a new trend in the process: the entry of governments, who had been virtually absent in the agenda-setting stage. In 1989 the UN General Assembly decided that a Climate Convention should be negotiated under UN auspices. The Climate Convention was signed at the 1992 Rio Summit. A legally non-binding aim of the Convention was for the industrialised states to stabilise their emissions at 1990 levels by the year 2000. The Convention entered into force in 1994. At the First Conference of the Parties to the Climate Convention (COP 1) in 1995, parties adopted the Berlin Mandate, in which they acknowledged the need to strengthen Annex I commitments beyond the year 2000.[4] This was taken a step further through the adoption of the Geneva Declaration at COP 2, in which parties called for quantified legally binding emissions reductions within specified time-frames. At COP 3 in Kyoto in 1997, the Kyoto Protocol was adopted.[5] According to this agreement, average emissions by Annex I parties were to be reduced by some 5 per cent from their 1990 levels within a five-year period from 2008 to 2012. A flexible approach to implementation was adopted with the three market-based mechanisms: joint implementation, emissions trading, and the Clean Development Mechanism (CDM).

It soon became clear that the Protocol was full of 'invisible brackets'. These were taken up at COP 4, where agreement was reached on a two-year action plan to establish more detailed rules. At COP 6 disagreement was still considerable, but at COP 7 in 2001 agreement was finally reached with the adoption of the Marrakech Accords. The Protocol entered into force in February 2005, when countries representing 55 per cent of the GHG emissions of industrialised countries in 1990 had ratified. The first meeting of the

[3] S. Andresen and S. Agrawala, 'Leaders, Pushers and Laggards in the Making of the Climate Regime', *Global Environmental Change*, Vol. 12, 2002, pp. 41–51.

[4] Annex I parties include industrialised countries that were members of the OECD in 1992, plus countries with economies in transition. See <http://unfccc.int/> for further details.

[5] Protocol to the United Nations Framework Convention on Climate Change; text reprinted in ILM, Vol. 37, 1998, pp. 22ff.

parties to the Kyoto Protocol (MOP 1) took place at COP 11 in Montreal in 2005. An informal process was initiated to adopt a follow-up plan to the Protocol after its commitments expired in 2012. At COP 13 in Bali in 2007, agreement was reached on the Bali Roadmap. This implied that, for the first time, all parties accepted formal negotiations on a new agreement following the Kyoto Protocol. Two working groups were established: the Ad Hoc Working Group on Further Commitments for Annex I parties under the Kyoto Protocol, and the Ad Hoc Working Group on Long-term Cooperative Action under the Convention. The latter was more important, since it included Kyoto non-members such as the USA and (at the time) Australia. Negotiations concentrated on four building blocks: mitigation, adaptation, finance and technology. The adoption of an Adaptation Fund was seen as a major achievement of the Bali meeting. However, the COP 15 in Copenhagen in December 2010 failed to produce the comprehensive international climate agreement many had hoped for. After two weeks of chaotic negotiations, the meeting produced the non-binding 'Copenhagen Accord'. While the signatories to the Accord agree in principle 'that deep cuts in global emissions are required according to science … so as to hold the increase in global temperature below 2 degrees Celsius' (Article 2), the Accord does not include common emissions reductions targets for achieving this aim. Instead, the agreement involves a 'pledge-and-review' approach whereby the parties themselves set their own emissions reduction targets. Thus, it commits Annex I parties to implement the 'quantified economy-wide emissions targets for 2020' which they themselves have submitted to the UNFCCC secretariat. Similarly, Non-Annex I parties are committed to implement the submitted 'mitigation actions'. The result is a set of widely diverging emissions-reduction targets and climate policy measures, with implementation to be ensured primarily through domestic legislation.[6] The Copenhagen Accord recognises the crucial importance of reducing emissions from deforestation and forest degradation in developing countries. The parties further agreed that developed countries would raise funds of USD 30 billion from 2010 to 2012, and that the world should raise USD 100 billion per year by 2020 to assist mitigation and adaptation measures in developing countries. These measures were formally adopted into the Convention through the 2010 Cancun Agreement – the first time that all major economies have pledged explicit action under the UN regime since negotiations started some twenty years ago.

[6] The list of policy actions submitted by the parties may be found at <http://unfccc.int/home/items/5262.php>.

ANALYTICAL PERSPECTIVES

The effectiveness of an international environmental regime is usually measured in terms of the output, outcome and impact of the regime.[7] 'Output' refers to the rules and regulations emanating from the institution involved. Provided that the rules are appropriate for dealing with the problem and that the parties comply with the rules, specific and strict rules have the potential to be more effective than vaguely formulated ones. It is not self-evident that these conditions are satisfied for the climate regime. Here we use the output indicator to assess some of the most important rules and regulations laid down in the UNFCCC and the Kyoto Protocol. While output is primarily a measurement of *potential* effectiveness, 'outcome' refers to actual behavioural change in the desired direction by key target groups as a result of the regime. Outcome, therefore, is a stronger indicator of effectiveness than is output. The methodological challenges associated with assessments of regime outcome, however, are severe. The key difficulty lies in establishing a causal link between the (here: climate) regime and the behaviour of relevant target groups, in a context where factors other than the establishment of the regime often are more important causes of behavioural change. It is beyond the scope of this chapter to examine changes in behaviour of key target groups: instead, we look at the development in national GHG emissions. Finally, 'impact' refers to changes in the state of the environment following from the regime. This is the most important indicator of effectiveness in the sense that it tells us the extent to which the problem that caused the establishment of the regime has been solved or not. Unfortunately, this indicator is fraught with even more severe methodological challenges due to the potential influence of a host of other factors in dealing with such a complex issue as the climate system. Therefore, it must be used with caution.

Compared to more established regimes, the climate regime is quite immature. This applies particularly to the most important part of the regime, the Kyoto Protocol. It came into force in 2005, and parties do have until 2008–2012 to 'deliver' on their most important commitments: the level of GHG emissions. Thus, the observations we present are bound to be preliminary. We have therefore added two 'softer' indicators: the normative and cognitive aspects of the regime.[8] The normative aspect deals with values and the moral principles that are promoted. We are particularly concerned with the norms laid down in relation to the North/South issue. Most research on the effec-

[7] E. Miles, A. Underdal, S. Andresen, J. Wettestad, J.B. Skjærseth and E.M. Carline, *Environmental Regime Effectiveness: Confronting Theory with Evidence* (Cambridge, MA: MIT Press, 2002).

[8] R.W. Scott, *Institutions and Organisations* (Thousand Oaks: Sage, 2001).

tiveness of international environmental regimes has focused on measuring 'hard' results, with less attention to the legitimacy of the regime in a North/South perspective.[9] Cognitive aspects concern the role of knowledge and science in the development and operation of the regime.

Several approaches have been developed to explain regime effectiveness.[10] Here we use some of the aspects elaborated in Miles et al.[11] Effectiveness is seen as a function of two factors: the nature of the problem, and the problem-solving capacity of the regime. The more politically and intellectually malign a problem is, the lower the effectiveness can be expected to be – and vice versa. This may seem a rather trivial observation, but policy-makers and researchers often forget to control for problem structure. That is, it may be more of an accomplishment to manage to move a very difficult problem slowly in the right direction, than to solve a very 'benign' problem fully. The nature of the problem tends to remain generally stable, although it may of course change – for example, with the introduction of new technology. We will not deal systematically with this indicator here. Suffice it to say that climate change stands out as an incredibly malign problem as it in essence affects every aspect of human life, in contrast to most other environmental problems. With regard to the problem-solving capacity of the regime, the gist of this argument is that some problems are attacked with more political and institutional energy than others. Problem-solving capacity is seen as a function of the distribution of power, leadership performance and the institutional structure of the regime. Power is often analysed in terms of the relation between 'pushers' and 'laggards': the stronger the pushers, the more effective the regime – and the converse. As we have argued elsewhere, the concept of 'leadership' is problematic to use.[12] It is ambiguous, adds little to more traditional approaches to negotiation behaviour, and has a strong normative component. The concept of leadership has flourished in deliberations over a climate regime; the EU has seen it as particularly important to take on the leadership role. However, research provides no conclusive evidence whether the EU deserves this label or not.[13] In this chapter we therefore use the

---

[9] A. Najam, 'Developing Countries and Global Environmental Governance: From Contestation to Participation to Engagement', *International Environmental Agreements: Politics. Law and Economics*, Vol. 3, 2005, pp. 303–321.

[10] A. Underdal and O. Young, *Regime Consequences: Methodological Challenges and Research Strategies* (Dordrecht: Kluwer Academic, 2004).

[11] Miles et al., *Environmental Regime Effectiveness*.

[12] T. Skodvin and S. Andresen, 'Leadership Revisited', *Global Environmental Politics*, Vol. 6, 2006, pp. 13–28.

[13] See for example J. Hovi, T. Skodvin and S. Andresen, 'The Persistence of the Kyoto Protocol: Why other Annex 1 Countries Move on Without the United States', *Global Environmental*

more traditional and less normative concept of 'influence'.[14] We assess influence by contrasting the positions and roles of key actors with the ensuing negotiating results, based mostly on secondary sources. Most emphasis is given to the key actors in the process of negotiations through most of this process – the USA and the EU. However, the emerging economies have become increasingly important in recent years. With regard to non-state actors we generally focus on the scientific community; environmental organisations are not included to any significant extent here.[15]

THE EFFECTIVENESS OF THE CLIMATE REGIME

The Climate Convention spells out a fairly strong normative message. The parties commit themselves to the long-term goal of stabilising atmospheric GHG concentrations at a level that 'would prevent dangerous anthropogenic interference with the climate system' (UNFCCC, Article 2). Thus, almost all nations of the world have agreed, in principle, to the goal that the atmospheric concentration of GHGs needs to be stabilised. The word 'dangerous', however, is ambiguous and contested, and we will show later that this norm has had limited practical significance. More important from a North/South legitimacy perspective, the Convention has adopted the principle of 'common but differentiated responsibilities'. This principle has been important in the sense that it has legitimised the South's rejection of taking on emissions commitments. The downside is that all developing countries are lumped together in one category, even if their interests and contributions to the problem vary significantly more than among countries in the North.

The cognitive message is also strong through the solid scientific underpinning provided by the IPCC. Scientists are involved in three Working Groups – on the science of climate change (WGI), on the impacts of climate change (WGII), and on response options to climate change (WGIII) – where they assess the state of knowledge within each respective area. Assessment reports have been published in 1990, 1995, 2001 and 2007. Draft reports are sent on comprehensive hearings for peer review. The reports then go to the Working Group and full Panel plenaries, made up of scientists and decision-

---

Politics, Vol. 3, 2003, pp. 1–24; and Oberthür and Kelly, 'EU Leadership in International Climate Policy', pp. 35–50.

[14] M. Betsill and E. Corell (eds), *NGO Diplomacy: The Influence of Nongovernmental Organizations in International Environmental Organizations* (Cambridge, MA: MIT Press, 2008).

[15] See for example L. Gulbrandsen and S. Andresen, 'NGO Influence in the Implementation of the Kyoto Protocol: Compliance, Flexibility Mechanisms and Sinks', *Global Environmental Politics*, Vol. 4, 2004, pp. 54–67; and M. Betsill, 'Environmental NGOs and the Kyoto Protocol Negotiations: 1995–1997', in Betsill and Corell (eds), *NGO Diplomacy*, pp. 43–67.

makers. The reports are usually adopted without much discussion, but the report summaries often require tough negotiations. In other words, the IPCC does not represent a 'pure' scientific process. Its intergovernmental status implies a vulnerability to politicisation, as experienced by the Panel especially during the initial phases of its operation. However, a balance between scientific autonomy and political involvement has gradually been achieved.[16] Initially, the involvement of scientists from the South was weak, reducing the legitimacy of the scientific message, but the representativeness has improved over time. For a long time, climate change was seen as a problem primarily in the North, even if all indications are that the South will be hit the hardest. More recently, climate change has also been recognised as a serious problem in key developing countries like China.

Since 2009, however, the credibility of the IPCC as well as of climate scientists has been challenged. It started with the 'climate-gate' incident, involving the leakage of about a thousand e-mails between researchers at the Climate Research Unit of the University of East Anglia to the Internet. Renowned climate scientists were accused of minimising the influence of views they disagreed with, while failing to document their own arguments. At about the same time, the 2007 IPCC Report's prediction that the Himalayas could lose all their glaciers in twenty years was shown to be unfounded.[17] As a consequence of these incidents, a series of reviews of the substance as well as process regarding the work of IPCC have been conducted. They have all concluded that the main substantive conclusions of the IPCC have been supported, but that the way the process is organised does not live up to requirements for transparency and accountability.[18] All the same, distrust of the IPCC and the economic crisis have led to reduced public interest as well as increased doubt about the seriousness of the problem.[19] However, attention tends to be cyclical, so public opinion may well change again.

The direct political effects of the scientific message on the measures adopted have been modest. Scientists have called for heavy reductions in emissions ever since the early 1990s, but global emissions continue to increase strongly. The indirect effect of the IPCC's work may be seen as more

---

[16] T. Skodvin, 'The Intergovernmental Panel on Climate Change', in S. Andresen, T. Skodvin, A. Underdal and J. Wettestad, *Science and Politics in International Environmental Regimes* (Manchester University Press, 2000), pp.146–181.

[17] 'Climate Change Assessment Must Try Harder', *The Economist*, 4 September 2010, pp. 78–79.

[18] Ibid.

[19] See for example BBC Climate Change Polls, February 2010, available at <http://news.bbc.co.uk/nol/shared/bsp/hi/pdfs/05_02_10climatechange.pdf>.

significant, particularly in terms of creating increased understanding of this complex issue.

Turning to output, the Kyoto Protocol is where we find specific provisions. The most important indicator regarding its potential effectiveness is the rules specifying emissions reduction commitments. The average emissions reductions generated by the Kyoto Protocol are some 5 per cent from 1990 levels, but there are considerable differences in the commitments of the Annex I parties. While the EU (as an aggregate) is to reduce emissions by 8 per cent, Australia is allowed to increase its emissions by 8 per cent. This reflects differences in the countries' energy mix and thereby differences in how costly it will be for them to change current emissions trajectories, but there is no precise model or calculation behind the adopted figures. Reductions are to be achieved within a multi-year period, and compliance is assessed on the basis of each country's average emissions during this period (2008 to 2012) of a basket of six GHGs. This allows countries to trade off greater reductions in some gases against lesser reductions in others. The Protocol also allows the Annex I Parties to take into account changes in land use, offsetting emissions by reducing their rate of land clearing or increasing the forest coverage (LULUCF). All these provisions are introduced to make implementation less costly. The emissions reductions targets of the Kyoto Protocol are relatively weak, but should nevertheless be seen as an improvement compared to the very general obligations in the Climate Convention. In a comparative perspective, the Kyoto Protocol is stronger than the Convention on Biological Diversity (CBD), where there are no binding targets or time-tables, but it is exceedingly weak compared to the level of commitments adopted in the ozone regime (the Montreal Protocol and subsequent amendments). Moreover, calculations have shown that even in the (unlikely) case of full compliance by all Annex I countries, the effects in terms of climate mitigation will be marginal.[20] Further weakening the significance of the commitments is the fact that emissions from aviation and shipping are not included. Finally, emissions are increasing much more rapidly in the South compared to emissions in Annex I parties. Given that developing countries are completely exempted from emissions reduction commitments, this serves to further reduce the significance of the Protocol.[21]

The main argument behind the three market-based mechanisms is cost-effectiveness and creating incentives for emissions reductions. These are to be supplemental to domestic emissions reductions, but it is up to the parties

[20] Hovi, Skodvin and Andresen, 'The Persistence of the Kyoto Protocol', p. 4.

[21] O. Røgeberg, S. Andresen and B. Holtsmark, 'International Climate Treaties: The Case for Pessimism', *Climate Law*, Vol. 1, 2010, pp. 177–199.

to decide the balance between domestic and international measures. Joint implementation opens up for project-based emissions trading between two Annex I countries. So far this provision has had little practical significance, due primarily to the limited interest and preparedness in Russia, which is the most promising partner for this implementation mechanism. The two other provisions are more important. The CDM allows Annex I parties to offset their emissions with documented emissions reductions in developing countries. It took time before the CDM approach got under way, but now it is gaining momentum. The major economies in the South and East have been granted the majority of CDM projects, with China the biggest recipient by far.[22] The poorer countries of the South have neither the infrastructure nor the institutional capacity to utilise this mechanism. Various other problems with the CDM have been identified, such as carbon leakage, high transaction costs due to the large UN bureaucracy required for verification of emissions reductions, and serious measurement problems related to the validity of many CDM projects.[23]

The purpose of setting up the emissions trading mechanism was to establish a price for GHGs and to encourage cost-efficient emissions reductions. The mechanism allows companies to reduce emissions at a lower cost through trade than would be possible if they had to implement the reductions on their own. The Kyoto Protocol has spurred the establishment of emissions trading systems in quite a few Annex I countries, the most comprehensive system being the European Union Emissions Trading System (EU ETS). There are similarities between the Kyoto Protocol trading system and the EU ETS, but there are also important differences.[24] The effects of the EU ETS on emissions have so far been limited, because too many allowances were allocated to industry during the first phase. The Commission has learned from this mistake and has strengthened the system for the 2008–2012 period and even more so for emissions trading in the post-Kyoto phase (2013–2020).

Turning to the outcome indicator, seen as the development in GHG emissions in Annex I parties, the latest figures from the UNFCCC (2010) look quite promising at first glance.[25] Between 1990 and 2008 aggregate emis-

---

[22] G.M. Heggelund and I.F. Buan, 'China in the Asia–Pacific Partnership: Consequences for UN Climate Mitigation Efforts', *International Environmental Agreements*, Vol. 9, 2009, pp. 301–317.

[23] Council on Foreign Relations, *Confronting Climate Change: A Strategy for U.S. Foreign Policy*, Independent Task Force Report No. 61 (New York: Council on Foreign Relations, 2009).

[24] J.B. Skjærseth and J. Wettestad, *EU Emissions Trading: Initiation, Decision-making and Implementation* (Aldershot: Ashgate, 2008).

[25] UNFCCC Subsidiary Body for Implementation, *National Greenhouse Gas Inventory Data for*

sions among the 41 Annex I parties had decreased by 6.1 per cent, excluding LULUCF.[26] However, there are important nuances in this seemingly positive picture. While GHG aggregate emissions in countries with economies in transition have decreased by some 37 per cent, aggregate emissions in other Annex I countries have increased by 7.9 per cent.[27] The reason for the strong reductions in GHG emissions in the economies-in-transition parties is not the climate regime but the massive reduction in industrial production in the wake of the collapse of the East European political and economic system in the early 1990s. This points up the importance of controlling for other factors when we trace causal effects. To get a better picture of the outcome of the climate regime, we will have to look at emissions from other major Annex I parties. Given that the USA is not party to the Kyoto Protocol, it is not surprising that its GHG emissions have increased significantly (13.3 per cent).[28] What is unexpected is that emissions in ten Kyoto Protocol parties have increased more than US emissions. Emissions in the EU, the most ambitious actor, have decreased by 11.3 per cent, illustrating that the EU and most EU countries are making a real effort to reduce their emissions.[29] An important reason for the reduced EU emissions, however, is the strong emission reductions in the UK and Germany (18.5 per cent and 22.2 per cent respectively).[30] This development is largely unrelated to the Kyoto Protocol. German emissions were significantly reduced in the 1990s due to the reunification of Germany and the ensuing closure of inefficient East German energy facilities. The UK reductions are due largely to the replacement of coal by reserves of offshore gas, implemented for economic reasons. Important nuances are added by controlling for population growth, giving figures for development in per capita emissions; in 2007 analysts stated that:

> Indeed, when one compare trends in per capita emissions, it is striking that the only country to see a decline other than the three "windfall reductions" (Russia, Germany and the UK) is the US, which has been vilified for its decision not to ratify the Kyoto Protocol.[31]

---

the Period 1990–2008, FCCC/SBI/20108/18, (New York: UNFCCC, 2010), available at <http://unfccc.int/resource/docs/2010/sbi/eng/18.pdf>.

[26] Ibid.

[27] Ibid.

[28] Ibid.

[29] Ibid.

[30] Ibid.

[31] K. Harrison and M. Sundstrom, 'The Comparative Politics of Climate Change', *Global Environmental Politics*, Vol. 7, 2007, p. 13.

A few more words should be added to this rather gloomy account. First, the Kyoto Protocol did not enter into force until February 2005 and the figures presented above are from 2008. One could argue that not much could be expected at this stage and the proof of the pudding in terms of goal achievement cannot be determined until 2012. However, this also implies that the norms and goals agreed on in the 1992 UNFCCC have had limited significance. Still, several measures to curb emissions have been adopted. While the USA has relied solely on voluntary measures and research & development, the EU and other Annex I parties have adopted more aggressive measures.

We can be very brief regarding the third indictor, the impact of the climate regime on the climate system, as it is obvious that the score is bound to be low.[32] This indicator is normally very difficult to use due to the influence of a host of other factors unrelated to the climate regime and the time it would take before the climate system responds to emissions reductions. However, when we know that instead of the heavy emission reductions repeatedly called for by the IPCC, emissions are increasing globally, we may safely conclude that the changes thus seen far in emissions trends are not sufficient for a dramatic reduction in the risk of a human-induced climate change. Any slower growth in emissions in recent years is likely to be a result of the global economic recession, and not the climate regime.

Considering the relative immaturity of the regime and the extreme malignancy of the problem, the rather low score on the different indicators is not surprising. How can the Copenhagen Accord and the Cancun Agreement be expected to affect the level of GHG emissions? Most analysts see a positive development in the Cancun Agreement, as it is, in contrast to the Accord, embedded in the UN system; moreover, all major states have for the first time pledged explicit action. If the promises to raise large sums of money as envisioned in the Cancun Agreement are realised, that will also make action in the South more likely. Nevertheless, according to one account: 'Still as important as these agreements may be, they represent only small steps in reducing global emissions.'[33]

EXPLAINING THE EFFECTIVENESS OF THE CLIMATE REGIME

Approach and Forum

First some remarks on the approach chosen for dealing with this problem and the choice of broader institutional nesting for the political process. The

[32] *Earth Negotiation Bulletin*, Vol. 12, No. 498, p. 29.
[33] Ibid.

agenda-setting stage was important for the subsequent design of the climate regime in at least two ways: First, because of the 'targets-and-timetables' approach introduced for the first time at the Toronto Conference in 1988. Second, the decision to give industrialised countries main responsibility for the problem, which implied a requirement that they should act first. After two decades of negotiations, these are still key features of the negotiations and the regime design. Another important factor was the all-inclusive *global* approach decided by the UN General Assembly. Already at the first meeting of the International Negotiating Committee in 1991 more than one hundred nations participated; since then, participation has expanded continuously. The Climate Convention was signed by 153 states in 1992, and now there are 194 parties. Since all nations of the world contribute to the problem and are all affected by it, it makes intuitive sense to choose a global approach. While this feature gives the regime higher legitimacy, it may also have contributed to lower effectiveness. The all-inclusive approach may be *one* reason for the slow progress. It is noteworthy that the 20 largest economies of the world are responsible for more than 80 per cent of global GHG emissions.[34] In this perspective, a negotiation setting with fewer participants might have been a more effective approach. For instance, the more limited and incremental approach chosen in the development of the ozone regime may help to explain the relatively faster progress of this regime.[35] This line of thinking is one reason for the recent US initiatives to establish negotiating arenas with limited participation as a supplement the UN process. We return to this below.

The Climate Convention

During the agenda-setting phase, the scientific and green NGO communities (e.g., at the Toronto Conference) called for ambitious targets within short time-frames. While the 'targets-and-timetables' approach was favoured by a large majority of the industrialised countries, increased government participation implied that the high ambitions from Toronto were tuned down. The new focal point became stabilisation of GHG emissions at 1990 level by the year 2000 (which also reflected a huge underestimation of the costs and complexities involved). Most key actors except the USA[36] wanted this to be

[34] *Climate Analysis Indicators Tool* (CAIT), Version 8.0 (Washington, DC: World Resources Institute, 2011), available at <http://cait.wri.org>.

[35] R.E. Benedick, *Ozone Diplomacy: New Directions in Safeguarding the Planet* (Cambridge, MA: Harvard University Press, 1998).

[36] D. Bodansky, 'The United Nations Framework Convention on Climate Change. A Commentary', *Yale Journal of International Law*, Vol. 18, 1993, pp. 451–558.

included as a legally binding obligation in the Convention. The USA, in contrast, argued that a binding target would be random and too costly, and advocated a 'no regrets' policy which also would allow time for more research to reduce the scientific uncertainty surrounding the climate issue. The soft political target (a non-binding aim to stabilise emissions) that was ultimately adopted in the Convention is thus often seen as a victory for the US position. The EU, caught up in its own internal negotiations over the controversial carbon/energy tax, played a limited role in the negotiations of the Climate Convention. The lack of unity within the EU at this time was made abundantly clear when the UK played a key role as a mediator between the USA and other parties (including other EU member states) at a later stage of the negotiation process.

The Kyoto Protocol

In the post-Rio era many key actors changed their position, thus creating new alliances. One main reason was better knowledge and understanding of the costs associated with emissions reductions and hence the national economic interests that were at stake. Canada, New Zealand and Australia, who had been associated with the pro-active group fronted by the EU, now switched sides and joined forces with the USA and Japan in a rather loose coalition known as JUSCANNZ (acronym for four of the main participants of the group). Later renamed the Umbrella Group and joined by Russia, the group is often seen as a 'laggard'. The Umbrella Group was constituted by the key proponents of a differentiated approach whereby commitments were set in accordance with country-specific variations in abatement costs. In contrast, realising the benefits that its economy-motivated shift from coal to gas would have for domestic abatement costs, the UK, which had previously pursued a cautious position, now stood forth as a pusher. The UK joined forces with another key 'pusher', Germany, and thereby strengthened the position of the EU. The EU, spearheaded by Germany, was to play a key role in the adoption of the 1995 Berlin Mandate.

While the USA only reluctantly accepted the Berlin Mandate, the Geneva Declaration, adopted at COP 2 in 1996, was enthusiastically embraced. The main reason for this shift in position was that Vice-President Al Gore, a long-standing climate activist, had succeeded in convincing President Clinton and the Administration to adopt a more pro-active international climate policy. This change in the US position was probably the most important factor enabling agreement on the Geneva Declaration. In the crafting of the Kyoto Protocol, the USA continued to play an influential role. According to one observer: 'Within this panoply, U.S. dominance is striking… and to

discover the sources of most ideas in the Protocol, one needs only to read the U.S. proposals of January 1997.'[37] Again Vice-President Gore played a key role. When negotiations were at the brink of collapse, Gore made a brief visit to Kyoto and mandated the US delegation to demonstrate increased flexibility. That paved the way for agreement.

The EU, on the other hand, was still struggling with internal conflicts and spent most of its energy at COP 2 hammering out an internal burden-sharing agreement. Prior to COP 3, however, the EU had finally agreed on a burden-sharing agreement, which allowed a more ambitious EU position. While this may have given the EU the moral upper hand prior to negotiations in Kyoto, observers seem less impressed by the EU's negotiation performance: 'The coherence of the U.S. administration contrasted with the unwieldy morass of EU decision making in the negotiation process.'[38] Supported by environmental NGOs, the EU opposed the flexible mechanisms pursued by the USA. The EU wanted more focus on domestic emissions reductions and claimed that the flexible mechanisms would undermine the environmental integrity of the Protocol. Nevertheless, the outcome of the negotiations has been characterised as a 'genuine compromise' in the sense that 'the EU got their numbers, the U.S. got their institutions, Japan got their prestige as a host, the JUSCANNZ got their differentiation and the developing countries avoided commitments.'[39]

The Post-Kyoto Process

While the US Administration may have been able to convince its international counterparts on the key design features of the Kyoto Protocol, it was not successful in convincing the US Senate about the need for a Kyoto Protocol. Even before the negotiations in Kyoto commenced, the Senate had expressed its sentiments concerning a 'Kyoto-type' agreement. In July 1997, the Senate unanimously adopted the Byrd–Hagel resolution, which implied that an international agreement that did not include 'meaningful' developing-country participation would not be ratified. The Kyoto Protocol was therefore never submitted to the Senate for ratification. At the international level, US negotiators attempted to water down the Kyoto commitments to make the agreement more acceptable to a broader set of domestic-level US interests. Again, however, the EU offered vigorous opposition. The EU wanted to

[37] M. Grubb, C. Vrolijk and D. Brack, *The Kyoto Protocol: A Guide and an Assessment* (London: Royal Institute of International Affairs, 1999), p. 12.
[38] Ibid.
[39] S. Andresen, *The Development of the Climate Regime: Positions, Evaluation and Lessons*, FNI Report 3/1998 (Lysaker: Fridtjof Nansen Institute, 1998), p. 28.

ensure domestic action and proposed a cap on emissions trading whereby 50 per cent of a party's commitment to emissions reductions would have to be implemented domestically. Similarly, the EU wanted to minimise the possibilities of using sinks as a climate measure.[40] These positions generated strong conflicts between the EU and the US-led Umbrella Group and caused the breakdown of negotiations at COP 6 in The Hague in 2000. In 2001 George W. Bush took over the US presidency, and in March that year he declared that the Kyoto Protocol was unacceptable to the USA. The EU and others tried to bring the USA back into the negotiations, but failed.

The EU then mobilised its political energy to ensure that the Protocol would enter into force without the USA. One might have expected negotiations to be easier after the US exit, but Washington's allies, 'the Gang of Four' (Australia, Canada, Japan and Russia), actively sought to weaken the commitments, and in this they were largely successful. The result was an increasingly watered-down agreement: While the outcome of the resumed COP 6 in 2001 has been labelled 'Kyoto Light', the COP 7 Marrakesh Accords have been described as 'Kyoto Ultra light'.[41] Interestingly, the EU now gave concessions on issues it previously had refused to concede to the USA. Thus, the revised interpretation of the Protocol was close to what the previous US Administration had worked actively to achieve.[42] Still, in the situation that arose with the US exit, had it not been for the pressure of the EU, the Kyoto Protocol may well have been killed off. Japan and Canada would probably not have ratified without the pressure exerted by the EU. Russia also had to ratify to satisfy the requirements for the Protocol's entry into force (see above). Given that its GHG emissions were more than 30 per cent below 1990 levels, Russia had nothing to lose from ratification. Russia was nevertheless reluctant, and it was only when the EU promised to support the Russian bid for WTO membership that it decided to ratify during the autumn of 2004, ensuring the Protocol's entry into force in March 2005.[43] Australia had decided to follow the US exit, but subsequently ratified the Protocol in 2007 after a change of government.

At COP 8 in New Delhi in 2002, the EU tried to initiate discussions on future commitments, after the Kyoto Protocol commitments were set to ex-

---

[40] A 'sink' is defined as 'any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere. Forests and other vegetation are considered sinks because they remove carbon dioxide through photosynthesis'. Source: 'UNFCCC Glossary of Climate Change Acronyms', available at <http://unfccc.int/essential_background/glossary/items/3666.php#S>.

[41] Hovi, Skodvin and Andresen, 'The Persistence of the Kyoto Protocol', p. 19.

[42] Ibid.

[43] Oberthur and Kelly, 'EU Leadership in International Climate Policy'.

pire in 2012.At this meeting the contours of a new alliance between the USA and the G-77 could be observed. They had one common interest: not to take on any kind of commitments. Together they constituted a formidable front, making it exceedingly difficult for the EU and other more pro-active parties to move the process forward. The EU wanted to prolong the Kyoto approach, only with stronger commitments. The USA rejected this, and wanted no discussions on future commitments. The major developing countries were frustrated at the lack of financial and technological transfers and the lack of progress in emissions reductions among the industrialised countries. Consequently, also the developing countries refused to discuss future commitments. The progress made in Bali should probably be seen as a reflection of the heightened political attention to climate change, creating the 'the Spirit of Bali'. Still, the US/EU haggling over numbers continued. Although negotiations had intensified, 'the Spirit of Bali' was subdued at the COP 14 in Poznan in 2008.[44] By then, the political context within which negotiations took place had been affected by the economic recession that hit the global economy in September that year. The atmosphere in Poznan was characterised more by the problems that economic recession would create, than by the 'green window of opportunity' it represented according to the optimists. In addition, the EU (again) was preoccupied with internal discussions over its climate and energy legislative package for implementing the EU's post-Kyoto climate ambitions. Although the election of Barack Obama created significant optimism for a more ambitious international US climate policy, the 'lame duck' US negotiators present at Poznan had little to add to the process. COP 14 became characterised by observers as 'one of those in-between COPs'.[45]

COP 15 was billed to become another milestone in the history of the climate change negotiations, and the interest shown by NGOs and the media was overwhelming. In light of the high expectations in many quarters, the actual negotiation process was a disappointment, and there was no agreed common document when the policy-makers arrived. Towards the very end a small group of emerging economies, China, India, Brazil and South Africa, together with the USA was able to hammer out the Accord, a document of two and a half pages, 'reminding us of the fable of the mountain that gave birth to a mouse'.[46] Many blamed the USA, the Senate in particular, for the

[44] 'A Brief Analysis of COP 14 & COP/MOP 4', *Earth Negotiations Bulletin*, Vol. 12, No. 395, 2008, pp. 17–19, at p. 19.
[45] Ibid.
[46] S. Andresen and E.L. Boasson, 'International Climate Cooperation: Clear Recommendations, Weak Commitments', in S. Andresen, E.L. Boasson and G. Hønneland (eds), *International Environmental Agreements: An Introduction* (London: Routledge, forthcoming 2011), pp. 87–122.

rather bleak outcome, but the most powerful veto-power was probably China, which managed to strip the document of all emission targets.[47] Many countries as well as the EU, completely sidelined in Copenhagen, were happy with neither the process nor the outcome, but accepted the accord as it was the only viable option. However, a handful of developing countries did not accept the Accord. Expectations were therefore extremely modest prior to COP 16 in Cancun. Against this background most observers deemed the outcome quite positive. However, the substance of the Agreement is fairly similar to the Accord, but the process was far more transparent and inclusive than the Copenhagen negotiations. The process was also made easier, as none of the truly controversial issues like prolongation of the Kyoto Protocol were dealt with.

Alternative or Supplementary Approaches

For a long time it could be argued that the Kyoto Protocol, although weak, was 'the only game in town'. That is no longer the case. In 2005 the USA and Australia were instrumental in establishing the Asia-Pacific Partnership on Clean Development and Climate (APP) and were joined by other economic and political heavyweights: China, India, Japan, South Korea and Canada (which joined in 2007). The partnership does not involve any binding commitments and is based on the philosophy that environmental quality improves with economic growth. The partnership represents a sectoral approach, where the partners collaborate on project-based and sector-specific benchmarks and standards to prevent environmental degradation, enhance economic growth and reduce GHG emissions. The main focus of the partnership is thus on technology development and transfer.[48] The establishment of the partnership, however, was dismissed by critics as a cynical diversion from progress made on the Kyoto Protocol and 'a red herring to distract attention from the Bush Administration's failure to tackle the greatest environmental challenge of our time.'[49] When the partnership was launched, therefore, observers strongly questioned its stated supplementary role to the UN track and the Kyoto Protocol. Rather, they argued that the partnership

---

[47] 'Global Deal on Climate Change in 2010 "All but Impossible"', *The Guardian*, 1 February 2010.

[48] For a detailed account of the Asia-Pacific partnership, see 'Special Issue: Exploring and Explaining the Asia Pacific Partnership on Clean Development and Climate', *International Environmental Agreements: Politics, Law and Economics*, Vol. 9, No. 3, 2009.

[49] Statement released by (then) House Democratic Leader Nancy Pelosi: 'Bush Administration Lacks Serious Policy on Global Warming', retrieved 31 January 2007 from <www.house.gov/pelosi/press/releases/Jan06/warm.html>.

could represent a heavy competitor to the UN track that could act derail and delay negotiations further.[50]

Another initiative under the Bush Administration that was viewed with suspicion as an effort to sidetrack the UN-based negotiation process was the establishment of the Major Economies Meeting in 2007. This constituted an informal negotiating arena at which the 17 largest economies, responsible for almost 80 per cent of global GHG emissions, met for informal discussions on how to approach the climate issue.

The APP has continued with the Obama Administration and is described as a low-key but quite effective tool in terms of practical implementation measures.[51] The sectoral approach this partnership represents may therefore continue to play a role in international climate negotiations in the coming years. Moreover, the Major Economies Meeting, initiated by the Republican Bush Administration was also endorsed by the Democratic Obama Administration in its initiation of the Major Economies Forum, early in 2009. The Forum was instrumental in reaching agreement at the G8 meeting in May 2009 on the '2°C target'. This meant agreeing that a global average temperature increase above 2 degrees Celsius could trigger irreversible climate change and should therefore be avoided; it was later laid down in the Copenhagen Accord and the Cancun Agreement.

Too Little Political Energy to Tackle a 'Malign' Problem

Climate change is a long-term issue with uncertain benefits and high up-front costs for most actors. It is characterised by a malign problem structure, and the regime is still quite immature. All the same, there have been some achievements. Considerable scientific advances have been made and innovative implementation mechanisms have been developed. Still, although we cannot measure performance conclusively before 2012, the picture so far looks rather bleak. The USA has been a rather consistent 'laggard' most of the time. It has also been the most influential player, with a decisive role in the making of the Climate Convention, the Kyoto Protocol as well as the Copenhagen Accord. In these processes the USA demonstrated considerable negotiation skills, but has influenced the process mostly through 'negative veto power'. The US position has also made it exceedingly easy for major developing economies like China to resist taking on legally binding

[50] J. McGee and R. Taplin, 'The Asia-Pacific Partnership on Clean Development and Climate: A Complement or Competitor to the Kyoto Protocol?' *Global Change, Peace & Security*, Vol. 18, 2006, pp. 173–192.

[51] Interviews at environmental think-tanks in Washington DC, February 2010.

economy-wide commitments. The reluctance of developing countries to take on commitments is understandable in light of the failure of the developed/industrialised countries to provide financial and technological assistance, and the poor performance of most Annex I countries in reducing their own emissions. Against such formidable opposition the EU has not been strong enough to lead the process forward, although it proved instrumental in getting 'hard figures' into the Protocol, as well as getting the Protocol ratified (unfortunately, without the USA). One reason the EU has not been more influential has been its problems with internal unity. Also, its cumbersome internal processes have obstructed the necessary negotiation flexibility, as was clearly demonstrated in Copenhagen. A further reason may be that, for the USA, even ambitious EU climate policies were not seen as outweighing the costs (in economic as well as environmental terms) associated with the unmitigated growth in GHG emissions in developing countries such as China and India. So far, therefore, negotiators have not succeeded in closing the gap between the advice from the scientific community and the actual provisions of the climate regime.

THE FUTURE OF THE CLIMATE REGIME

Judging from the experiences of some twenty years of negotiations, there is no reason for optimism with regard to the world's ability to deal effectively with the climate change problem in the years to come. More specifically, the future looks bleak for three reasons: lack of political will among key actors, the ineffectiveness of the UN approach, and, third, the prospects for strong economic growth in the global East and South. There was considerable optimism after the election of President Obama in the USA as he had the climate change issue high on his agenda, but the November 2010 mid-term elections demonstrated that neither the US public nor Congress was ready to follow him. At present, therefore, there seem no chances that federal climate legislation will be adopted in the USA. Nor is it the only 'difficult' player. Japan and Russia have clearly stated that they are not interested in an extension of the Kyoto Protocol; moreover, emissions are rising steeply in countries like Australia and Canada, although both have ratified the Kyoto Protocol. The only major Annex I actor that seems to give high priority to the issue is the EU – but, with the drop in public concern combined with considerable internal opposition, it remains to be seen how long this role can be upheld. Recent years have also witnessed strong growth in the influence of the emerging economies, China in particular, reflecting new geopolitical realities. China has done much domestically to reduce its emissions from a 'business as usual' scenario, but continued economic growth is still its first prior-

ity, which means that also emissions will continue to rise. Indeed, the same goes for all other developing countries. In view of the historical responsibility of the Annex I countries for this problem, we can hardly expect any front-runners among the G-77 countries in the foreseeable future. The two most important actors in future negotiations will be the USA and China. These two biggest emitters seem locked in mutually contingent positions, with neither willing to take on commitments without guarantees that also the other will do so. Moreover, China had to take much of the blame for the deadlock that characterised the Copenhagen meeting. In Cancun, open sparring was avoided – helped by the fact that all the difficult issues were postponed.

Some observers have also expressed deep scepticism to the UN system itself as an appropriate arena for climate negotiations – a view reinforced by the chaos and mismanagement that characterised the Copenhagen meeting.[52] While less than 20 countries control more than 80 per cent of global emissions, the UN operates under a decision rule of consensus whereby all 194 parties must agree, in order for an agreement to be adopted. In Copenhagen a handful of countries prevented the Copenhagen Accord from acquiring official UN status. Despite some progress in this regard in Cancun, that was no real test of the effectiveness of the UN approach, as the most controversial issues were not on the table.

Within the UN framework, considerable energy has been expended on negotiating long-term targets. But what practical value do such goals have in terms of actually reducing emissions? Former deputy director of the International Energy Agency, William Ramsay, holds that these long-term targets (for 2020, 2030 and 2050) are 'meaningless'. Instead, he argues, targets need to be formulated in accordance with the political cycle 'so that the politicians who put [these] targets into place can be held accountable for whether or not they are being achieved.'[53]

Considering these obstacles, it may be well beyond 2012 before a new legally binding instrument could be in place. Perhaps today's rather low-key 'bottom–up' and 'pledge and review' approach without legally binding targets is in fact what is politically feasible to achieve. Considering the slow pace of the UN approach it is also likely that the process will be continued outside the UN track as well. In that case, it is important to have close linkages among and between the different forums, so as to forge synergies

[52] 'Global Deal on Climate Change in 2010 "All but Impossible"', *The Guardian.*

[53] 'Interview: UN Climate Talks Must Move Beyond Rhetoric', *EurActiv.com*, 8 December 2008, available at <www.euractiv.com/en/climate-change/interview-un-climate-talks-move-rhetoric/article-177768>.

and not conflicts. Regardless of approach, however, it is hard to see how this problem can be dealt with effectively as long as the political will is lacking among key actors. In fact, even if most Annex I parties together with China should prove able to reduce their emissions sharply, the effects on the climate system would be very modest. The long-term challenge, therefore, is to achieve significant reductions in *all* major emitters. To achieve the 2°C target – which some scientists hold is not enough to prevent 'dangerous anthropogenic interference with the climate system' – global emissions will need to be reduced by at least 50 per cent by 2050, and by 80 to 90 per cent by the year 2100.[54] We should consider this in light of the scenario of 600 to 1200 per cent growth in the world economy over the next century due to strong economic growth in developing and economies-in-transition countries,[55] followed by steep population growth in the developing world, resulting in a total world population of perhaps 9.5 billion already by 2050.[56] The key players of today – the USA, the EU and China – will not be the key players of tomorrow. Even if China could reduce its emissions by 95 per cent by the year 2100 from a business-as-usual baseline, that would still reduce global average temperature by a mere 0.3° C.[57] Thus, even taking into account continued technological improvements and significant financial transfers, the 2°C target still looks like 'mission impossible'.

[54] Røgeberg, Andresen and Holtsmark, 'Climate Treaties: The Case for Pessimism'.

[55] IPCC, *IPCC Special Report: Emissions Scenarios*, a special report of Working Group III (Cambridge University Press, 2000).

[56] United Nations, 'World Population Prospects: The 2008 Revision', available at <http://esa.un.org/unpp>.

[57] Røgeberg, Andresen and Holtsmark, 'Climate Treaties: The Case for Pessimism', p. 10.

11

Sea-Level Rise and the Law of the Sea: Future Options

Moritaka Hayashi[*]

According to the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC), released in 2007:

> Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level …. Rising sea level is consistent with warming. Global average sea level has risen since 1961 at an average rate of 1.8 [1.3 to 2.3] mm/yr and since 1993 at 3.1 [2.4 to 3.8] mm/yr, with contributions from thermal expansion, melting glaciers and ice caps, and the polar ice sheets.[1]
>
> …
>
> There is high agreement and much evidence that with current climate change mitigation policies and related sustainable development practices, global greenhouse gas emissions will continue to grow over the next few decades.[2]

The AR4 projects that, depending on different scenarios of greenhouse gas emissions, sea-level rise by the end of this century would range from 0.18 to 0.59 metres.[3] The UN Secretary-General reported in 2008 that sea levels are rising faster than expected, and that warming from a business-as-usual emissions path could lead to a sea-level rise of 0.5 to 1.4 metres in the course of this century.[4]

---

[*] This chapter draws on a paper presented by the author at the International Symposium on Islands and Oceans, held in Tokyo, 22–23 January 2009.

[1] Intergovernmental Panel on Climate Change, *Climate Change 2007: Synthesis Report. Summary for Policy Makers*, p. 2; see also Table SPM.1 in ibid., at p. 3. Available at: <www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf>.

[2] Ibid., p. 7.

[3] Ibid., p. 8.

[4] *Oceans and the Law of the Sea: Report of the Secretary-General*, UN doc. A/63/63, of 10 March 2008, p. 89.

Such a rise could have significant impacts on the baselines currently applied by coastal states and the extent of the various maritime zones claimed on the basis of such baselines. Briefly put, the main legal problems caused by sea-level rise under the existing law of the sea involve the obligation of the affected coastal state to adjust its baselines to geographic changes, and thus the need to adjust also the outer boundaries of maritime zones it claims as measured from such baselines. Such adjustments may include, in the case of the territorial sea, the loss of its sovereignty over part of it; and, in the case of the exclusive economic zone (EEZ), the loss of its sovereign rights over part of the natural resources. In a more serious scenario, the baselines of a small island may disappear if it is submerged completely, and thus the territorial sea and the EEZ it has generated may be lost. Moreover, such 'ambulatory' baselines that are to be adjusted to sea-level rise are necessarily unstable and uncertain. Particularly in areas rich in natural resources, they may become a source of dispute with neighbouring states.

Various physical measures have already been or are being taken by coastal states to protect against coastal erosion. Such adaptive measures, however, cannot always serve as an effective permanent solution against the massive force of nature unleashed by climate change. This chapter focuses on possible long-term legal and policy measures for coping with adverse impacts on the maritime zones of coastal states. These options will be discussed first. Thereafter, we examine the possible procedures and legal forms or instruments for pursuing the most preferable among such options – the adoption of new rules of international law. Before focusing on these future options, a brief summary of the effects of sea-level rise on baselines and maritime boundaries, and the problems they could cause, is given in the following section.

EFFECTS OF SEA-LEVEL RISE ON BASELINES AND MARITIME BOUNDARIES

Baselines for measuring the territorial sea and other maritime zones, as defined by the law of the sea, are not necessarily permanently fixed: some of them move as the geographical features change due to forces of nature. There are several types of baselines. The United Nations Convention on the Law of the Sea (LOS Convention) provides, first, that the 'normal baseline' for measuring the breadth of the territorial sea is the low-water line along the coast, as marked on large-scale charts officially recognised by the coastal state (Article 5). In the case of islands situated on atolls or having fringing reefs, the baseline is defined as the seaward low-water line of the reef, as shown by the appropriate symbol on charts officially recognised by the

coastal state (Article 6). Low-tide elevations do not normally generate maritime zones. However, where a low-tide elevation is situated wholly or partly at a distance not exceeding the breadth of the territorial sea from the mainland or an island, the low-water line on such elevation may be used for measuring the territorial sea (Article 13).

The LOS Convention further provides that, in certain localities where the coastline is deeply indented and cut into, or if there is a fringe of islands along the coast in its immediate vicinity, the coastal state may employ the method of 'straight baselines', joining appropriate points in drawing the baseline in accordance with the detailed rules and conditions specified in Article 7. Such 'appropriate points' may be small islands or rocks which are above water at high tide. Similar straight lines may also be used across the mouth of a river between points on the low-water lines of its banks (Article 9). With regard to a bay which meets the definition in Article 10, where the distance between low-water marks of its natural entrance points does not exceed 24 nautical miles,[5] a straight closing line may be drawn between these two low-water marks as baseline (Article 10(4)).

Lastly, an archipelagic state may draw 'straight archipelagic baselines', in accordance with the provisions of Article 47, by joining 'the outermost points of the outermost islands and drying reefs on the archipelago' (Article 47(1)).[6]

When sea level rises, the low-water line normally moves landward. Since the low-water line must be marked on charts in accordance with Article 5 of the LOS Convention, the coastal state is then required to replace the older line with the new one. In case of baselines on reefs, the new baselines must be shown on charts by appropriate symbols, as required by Article 6. Where straight baselines are drawn using a small island or rock as a base point, and sea-level rise has caused the base point to be submerged at high tide, the coastal state must change the straight baseline segment concerned, shifting the straight baseline system landward. In the case of rivers, the closing lines would have to be shifted landward. With regard to bays, where the low-water marks on their entry-points shift, the closing line may have to be adjusted in order to meet the conditions specified in Article 10. Where an

[5] All references to 'miles' hereinafter are nautical miles.

[6] It is not clear whether 'drying reefs' mean fringing reefs, or one type of low-tide elevations. In the latter case there is an inconsistency with paragraph 4 of the same Article, which provides that straight archipelagic baselines shall not be drawn to and from a low-tide elevation unless lighthouses or similar installations permanently above sea level have been built on it or where it is situated wholly or partly at a distance not exceeding the breadth of the territorial sea from the nearest island. L.M. Alexander, *Alternative Interpretations of Geographic Articles in the 1982 LOS Convention* (Kingston, RI: University of Rhode Island, 1990), pp. 58–59.

archipelagic state has drawn straight archipelagic baselines using an island which has subsequently become submerged at high tide, or where it has drawn archipelagic baselines to and from a 'drying reef' that has subsequently become submerged at low tide, the archipelagic state must likewise adjust the archipelagic baseline segments without using such features as base points.

One of the consequences accompanying such changes of baselines is the landward shifting of the outer boundaries of the territorial sea, the contiguous zone and the EEZ, as well as those outer limits of the portions of the continental shelf that are established by distance measured from the baselines discussed above.[7] Such shifting may involve the loss of sovereignty or sovereign rights of the coastal state over natural resources or jurisdiction with respect to activities in the outer boundary areas concerned. Depending on the interests involved, such shifting could prove a source of potential dispute with other countries interested in the resources concerned or in the exercise of jurisdiction, particularly on the basis of freedom of the high seas. In areas where neighbouring countries share a maritime space of less than 400 miles and no delimitation agreement with permanently fixed limits has been concluded, shifting of baselines or submergence of some islands may have significant effects on the extent of the EEZ and continental shelf claims.

The ambulatory nature of baselines thus inevitably makes maritime boundary situations unstable and uncertain. As Caron has pointed out, uncertainty in boundaries is 'a prime ingredient in many recipes for interstate and private transnational conflict'.[8]

Another potentially serious consequence concerns small islands or rocks. According to the LOS Convention, an 'island', defined as a naturally formed area of land surrounded by water, and above water at high tide, is entitled to the various maritime zones just as other land territory; further, rocks which cannot sustain human habitation or economic life of their own have no EEZ or continental shelf (Article 121). Sea-level rise may cause some of such islands and rocks submerged completely, with no baselines left from which

---

[7] The outer limits of the continental shelf may be established by the coastal state by using various methods according to the geographical or geological features of the various parts of the shelf. Where appropriate, the coastal state may choose the limit of 200 miles from the baselines, or the outer edge of the continental margin where it extends beyond 200 miles, but in no case more than 350 miles from the baselines (Art. 76). See further discussion below. As to the continental shelf beyond 200 miles, see Part V in: D. Vidas (ed.), *Law, Technology and Science for Oceans in Globalisation* (Leiden: Martinus Nijhoff, 2010), pp. 423–589.

[8] D.D. Caron, 'When Law Makes Climate Change Worse: Rethinking the Law of Baselines in Light of a Rising Sea Level', *Ecology Law Quarterly*, Vol. 17, 1990, p. 645.

maritime zones are to be measured. Although no authentic interpretation has been given on the highly ambiguous provision of Article 121,[9] and state practice is divergent on the treatment of such islands or rocks, the literal interpretation of the article appears to imply that the state to which such islands or rocks belong could lose the maritime spaces generated by them. The magnitude of the loss of maritime zones could be huge for some islands: the area of EEZ extending up to 200 miles all around an island, for example, would be more than 430,000 square kilometres. Moreover, in an extreme case, a sovereign state consisting solely of small islands and rocks may lose its land territory and hence its maritime zones when they become completely submerged; or its population may have to move elsewhere due to the near-submergence of its islands. In the latter case, that state could lose its entitlement to the EEZ. It could also lose the entitlement to the continental shelf unless its outer limits have been permanently established in accordance with the LOS Convention, as further discussed below.

LEGAL AND POLICY OPTIONS FOR MITIGATING EFFECTS OF SEA-LEVEL RISE

Several long-term legal and policy options are available to coastal states for mitigating the negative consequences for their maritime zones caused by sea-level rise. These options may be divided into two categories: those which could be taken under the existing international law regime by making full use particularly of the provisions of the LOS Convention provisions, and those which go beyond the existing law, thus requiring the creation of new rules of international law. These options will be discussed below, together with the options for special cases of island states which face the possibility of total submergence or of losing the capacity to sustain human habitation.

Wider Use of Existing Rules of International Law

As described above, the LOS Convention contains several technically detailed provisions for drawing baselines and fixing the outer limits of maritime zones. Coastal states, including archipelagic states, may make wider use

[9] On the ambiguous nature of Art. 121, see, e.g., B. Kwiatkowska and A.H.A. Soons, 'Entitlement to Maritime Areas of Rocks Which Cannot Sustain Human Habitation or Economic Life of Their Own', *Netherlands Yearbook of International Law*, Vol. 21, 1990, pp. 180–181; R. Kolb, 'L'interprétation de l'article 121, paragraphe 3, de la Convention de Montego Bay sur le droit de la mer: Les "rochers qui ne se prêtent pas à l'habitation humaine ou à une vie économique proper…"', *Annuaire français de droit international*, Vol. 40, 1994, p. 879; E.D. Brown, *The International Law of the Sea*, Vol. I (Aldershot: Dartmouth, 1994), pp. 150–151; and R.R. Churchill and A.V. Lowe, *The Law of the Sea*, 3rd edn (Manchester University Press, 1999), p. 50.

of the rules relating to straight baselines and low-tide elevations. Coastal states may also permanently fix the outer limits of their continental shelf with a view to securing maximal maritime space not affected by sea-level rise. In addition to the LOS Convention, numerous bilateral agreements regulate the delimitation of maritime boundaries, in many cases permanently fixing such boundaries irrespective of subsequent geographical changes that may affect the baselines. Wider use of such agreements is therefore another means available for dealing with the effects of sea-level rise in relation to maritime boundaries with neighbouring states.

Use of straight baseline

Straight baselines, according to Article 7, may be drawn to and from rocky or other prominent points unlikely to suffer erosion from sea-level rise. Once such lines are legally drawn, subsequent changes in the low-water mark for normal baselines along the coasts situated within the straight baselines would have no effect on the baseline for measuring maritime zones.[10] Here it should be stressed that, precisely because the use of straight baselines has often been abused, leading to protests from other countries, states should be cautious and follow strictly the rules set out in Article 7.[11]

As stated above, straight baselines cannot be drawn to and from low-tide elevations. However, exceptions are made where lighthouses or similar installations which are permanently above sea level have been built on them (Article 7(4)). Similarly, an archipelagic state may draw straight archipelagic baselines to and from low-tide elevations where similar installations have been built on them (Article 47(4)). Thus, where conditions under Articles 7 and 47 are met, coastal states and archipelagic states could construct lighthouses or similar installations on appropriate low-tide elevations in order to enable them to be used as straight baseline points.

Establishment of outer limits of the continental shelf

The LOS Convention defines the outer limit of the continental shelf as either the outer edge of the continental margin or the line at a distance of 200 miles from the baseline where the continental margin does not extend to that distance (Article 76(1)). Where a coastal state claims an extended continental

[10] See S.P. Menefee, '"Half Seas Over": The Impact of Sea Level Rise on International Law and Policy', *UCLA Journal of Environmental Law and Policy*, Vol. 9, 1991, p. 212, citing E.C.F. Bird and J.R.V. Prescott, 'Rising Sea Levels and National Maritime Claims', *Marine Policy Reports*, Vol. 1, 1989, p. 193.

[11] See J.A. Roach and R. Smith, 'Straight Baselines: The Need for a Universally Applied Norm', ODIL, Vol. 31, 2000, p. 47.

shelf beyond 200 miles, relevant information must be submitted to the Commission on the Limits of the Continental Shelf (CLCS). The limits of the shelf established by the coastal state on the basis of the Commission's recommendations 'shall be final and binding' (Article 76(8)). The LOS Convention further provides that the coastal state shall deposit with the UN Secretary-General charts and relevant information, including geodetic data, 'permanently describing the outer limits of its continental shelf', and the Secretary-General shall give due publicity thereto (Article 76(9)). This implies that when a coastal state deposits with the Secretary-General the outer limits of its continental shelf, such limits must be described as *permanent* for not only those of the extended shelf, but also those of the 200-mile limit.[12] The permanent nature of the 200-mile limit would mean that if the baselines for measuring that limit recede in the future due to sea-level rise, and as a consequence the outer limits of the territorial sea move landward, the breadth of the continental shelf lying adjacent to the territorial sea increases.[13] The same conclusion can be drawn for those outer limits of the extended shelf which are fixed at a distance of 350 miles from the baselines in accordance with Article 76(5). These effects of the permanent nature of the continental shelf limits are of particular importance for remotely-located small islands which are likely to be submerged or become uninhabitable when sea levels rise. Some such islands could then be regarded as 'rocks' under Article 121(3), and could lose the continental shelf as well as the EEZ that the islands have generated.

It is accordingly advantageous for coastal states to follow the above-mentioned procedure for permanently establishing the outer limits of their continental shelf for both the 200-mile limit and the outer edge of the continental margin lying beyond that limit. This is of crucial importance particularly if an island state becomes inhabitable or submerged completely due to sea-level rise, as discussed later in this chapter.

Bilateral delimitation agreement

It is a fundamental principle of international law that *pacta sunt servanda*, i.e., treaties are binding on their parties.[14] Exceptions are made to this rule, however, when a party invokes a 'fundamental change of circumstances' from those existing at the time when the treaty was concluded. That party

[12] A.H.A. Soons, 'The Effects of a Rising Sea Level on Maritime Limits and Boundaries', *Netherlands International Law Review*, Vol. 37, 1990, p. 216.

[13] See ibid. Soons considers this provision is remarkable, since such a provision has not been included for the outer limit of the EEZ, even though the regime of the EEZ includes jurisdiction over seabed resources.

[14] Art. 26 of the 1969 Vienna Convention on the Law of Treaties, UNTS, Vol. 1155.

may in such a case unilaterally terminate the treaty, provided that the conditions set out in the Vienna Convention on the Law of Treaties are met.[15] It may well be argued that a rise of sea level can be regarded as such fundamental change when the rise substantially affects the baselines that have been drawn by using the ambulatory system as described above, rather than by using permanently fixed points described on charts or specified by geographical coordinates. There is, however, an explicit provision in the Vienna Convention intended to exclude agreements establishing a boundary from the application of this rule of fundamental change of circumstances.[16] It is therefore prudent for a state wishing to avoid any future change in maritime boundaries when major sea-level rise occurs to conclude bilateral agreements using permanently fixed points for drawing boundary lines.

Adoption of New Rules of International Law

The options under existing law of the sea regime for avoiding or mitigating adverse effects of sea-level rise, as discussed above, are quite limited. In fact, during the Third UN Conference on the Law of the Sea, there was no widespread recognition of the possible problems of sea-level rise, and negotiators did not anticipate that there would be a significant global regression of coastlines.[17] There are thus no provisions in the LOS Convention for dealing with possible rises in sea level or the impact of natural shoreline change on baselines, except for the special case of highly unstable coastlines in a delta or similar area, covered by Article 7(2).[18] We must therefore conclude that the only general legal solution to the problems involved lies in the creation of new rules of international law.

What, then, should be the contents of such new rules of international law? In the last two decades, some authors have made suggestions for such new rules. According to Caron, for instance, the LOS Convention provides that,

---

[15] Ibid., Art. 62(1).

[16] Ibid., Art. 62(2)(a).

[17] D. Freestone and J. Pethick, 'Sea Level Rise and Maritime Boundaries: International Implications of Impacts and Responses', in G.H. Blake (ed.), *Maritime Boundaries* (London: Routledge, 1994), p. 79; Caron, 'When Law Makes Climate Change Worse', p. 636.

[18] Alexander, *Alternative Interpretations of Geographic Articles*, p. 64. Art. 7(2) provides that in such a case the appropriate points may be selected to draw straight baselines along the furthest seaward extent of the low-water line, and that notwithstanding subsequent regression of that line, the straight baselines shall remain effective until changed by the coastal state in accordance with the Convention. This provision was based on a draft originally proposed by Bangladesh for application to such areas as the Ganges delta. Alexander points out that one of the conditions which may cause the shoreline to retreat is a rising in sea level, resulting either from a global rise, or the subsidence of the adjacent land mass (ibid., p. 54).

in situations other than those covered by Article 7(2), the outer boundaries of the maritime zones of coastal states are ambulatory, moving with the baselines from which they are measured.[19] He argues that the current law of baselines serves to encourage nations to expend 'wasteful funds' in order to preserve baselines, as well as leading to uncertainty as to the boundaries of some maritime zones. He suggests therefore that the present law should be replaced by a system under which the boundaries of all maritime zones, in particular the territorial sea and the EEZ, are fixed on the basis of currently accepted baselines.[20] Caron argues that such fixing of maritime boundaries would be fair and equitable: it does not affect the allocation agreed to at the Third UN Conference on the Law of the Sea, because it merely freezes the present division of authority over the oceans; further, if maritime boundaries are thus fixed, states do not gain any additional portion of the surface of the Earth even if baselines recede subsequently due to sea-level rise.[21]

In a similar vein, Judge (currently President) Jesus of the International Tribunal for the Law of the Sea (ITLOS) considers it reasonable for the sake of stability and for promoting orderly relations over ocean resources and uses that, once baselines have been established in accordance with relevant provisions of the LOS Convention, and given publicity thereto under Article 16(2), they should be seen as permanent baselines, irrespective of later changes resulting from supervening phenomenon such as sea-level rise. Judge Jesus would apply this argument also to new-born islands and future qualification of rocks under Article 121.[22] He considers it legitimate that a substantial rise in sea level should not entail the loss of a state's ocean space or its rights over maritime resources already recognised by the LOS Convention and by the community of nations. This suggestion would not conflict with established maritime zones and resources of any country, nor would the international seabed or the high seas commons be affected.[23]

A slightly different suggestion, although with the same objective, has been made by Soons, who focuses on the outer limits of maritime boundaries rather than the position of baselines. He calls for a new general rule according to which coastal states are to be entitled, in the case of landward shifting of the baseline as a result of sea-level rise, to maintain the outer limits of the territorial sea and of the EEZ where they were located at a certain moment in

[19] Caron, 'When Law Makes Climate Change Worse', p. 635.
[20] Ibid., pp. 623, 640–641.
[21] Ibid., p. 648.
[22] J. L. Jesus, 'Rocks, New-born Islands, Sea Level Rise and Maritime Space', in J. Frowein, K. Scharioth, I. Winkelmann and R. Wolfrum (eds.), *Verhandeln für den Frieden. Negotiating for Peace* (Berlin: Springer, 2003), pp. 602–603.
[23] Ibid., p. 602.

accordance with the general rules in force at that time. Soons cites Article 76(9) of the LOS Convention relating to the outer limits of the continental shelf, which serves as a precedent in support of the acceptance of such a rule.[24]

The three authors cited above – Caron, Jesus and Soons – call for the ambulatory baselines or the outer limits of the territorial sea and the EEZ under the LOS Convention to be replaced by the permanently fixed ones. All have the same goal of fixing the outer limits of the maritime zones that the coastal states establish in accordance with the LOS Convention provisions *before* sea-level rise actually forces baselines to be re-drawn landward. In order to achieve this goal, Caron and Jesus advocate the freezing of baselines, whereas Soons argues in favour of fixing the outer limits, leaving the baselines ambulatory. Although the goal is common, these two approaches imply an important difference in the legal status of the shore area that will be submerged due to sea-level rise. The fixing of baselines would mean that the future submerged area becomes internal waters, whereas fixing only the outer limits of maritime zones would result in expanding the breadth of the territorial sea landward to the extent of the shifting of baselines. With this latter approach, the newly submerged area would thus be subject to the regime of innocent passage. Of the two approaches, the former appears more readily justifiable, since the newly submerged area was once part of the land territory of the coastal state and the submerging was caused by no fault of that state. In addition, the former has the merit of not changing the rules on the breadth of the territorial sea and the EEZ as stipulated in Articles 3 and 57, respectively. Moreover, with the second approach it is not clear where the new baseline would be located, if, for instance, an entire island in mid-ocean has been submerged.

Some doubts have been expressed as to the idea of freezing the current baseline system. Referring to the cases of abuse of several countries in establishing straight baselines allegedly in violation of the rules in Article 7 of the LOS Convention, Palmer argues that freezing the existing system would perpetuate such excessive claims without any hopes that they could be revised.[25] He suggests that other measures could include further refinements of the parameters for establishing straight baseline systems in particular.[26] Palmer's view, however, is limited to the drawing of straight baselines only,

[24] Soons, 'The Effects of a Rising Sea Level', p. 225. See also Freestone and Pethick, 'Sea Level Rise and Maritime Boundaries', p. 76.

[25] T. Palmer, 'Sea Level Change and Baselines', in *Proceedings of the Canadian Hydrographic Conference and National Surveyors Conference 2008*, available at <http://pac.chs.gc.ca/files/session_2A/2A-2_Palmer.pdf>, p. 4.

[26] Ibid., p. 9.

and that in no way leads to a general solution to the problems caused by sea-level rise.

From the foregoing discussion, it would seem that the idea of freezing, and thus permanently fixing, the baselines and consequently the outer limits of various maritime zones has considerable merits and is worth pursuing further in order to find ways and means to enable its formal adoption by the international community. In summary, the suggestion appears fair and equitable, as it would enable a coastal state to keep the newly submerged space as internal waters to compensate for the loss of land territory caused by sea-level rise, and also to retain its sovereignty or sovereign rights over the maritime zones it claims lawfully, including those generated by an island, even after the island becomes submerged or uninhabitable. This approach would not deprive any other state of any of its maritime space, nor would it reduce the area of the high seas. Furthermore, it would contribute to the stability and orderly relations involving maritime borders of neighbouring countries, and thus to 'the strengthening of peace, security, cooperation and friendly relations among all nations' – a major objective of the LOS Convention as enshrined in its preamble.

In further pursuing the idea of freezing the baselines and outer limits of maritime zones, it would be important to clarify exactly at what moment they should be frozen. Various options exist, including the time of entry into force of the LOS Convention, and the establishment of baselines by each state according to the relevant provisions and the publicity given thereto under Article 16(2). The latter would appear to be the better option, since it is the explicit obligation of the coastal state to show its baselines on charts or indicate geographical coordinates of baseline points, and to give due publicity to them, with a copy to be deposited with the UN Secretary-General.[27] There is, however, no time-limit for states parties to fulfil this obligation, and many have not yet done so.[28] This option might well have the additional effect of encouraging states to step up efforts to establish their baselines.

The proposal advanced here may be formulated in relatively simple provisions in an appropriate instrument, which should be adopted in the

---

[27] Arts. 5 and 16. For the continental shelf, Art. 76(9) requires the coastal state to deposit with the Secretary-General 'charts and relevant information', permanently describing the outer limits. Where the outer limit is drawn at a distance of 200 miles from the baselines, it is assumed that such 'relevant information' includes position of the baselines.

[28] According to the UN Division for Ocean Affairs and the Law of the Sea, as at the end of 2008, 'only a relatively small number of States Parties have fully or partially complied with their deposit obligations'. See <www.un.org/Depts/los/LEGISLATIONANDTREATIES/backgroud_deposit.htm>.

future, as discussed further in this chapter. The core provision of such new rules might read something like the following:

> A coastal state may declare the baselines established in accordance with the relevant provisions of the LOS Convention as permanent once it has shown them on charts of an adequate scale or described them by a list of geographical coordinates, and given due publicity thereto, notwithstanding subsequent changes in geographical features of coasts or islands due to sea-level rise.

Policy Options for Submerging Island States

The above discussion relating to baselines applies generally to small islands. However, the special case where all the islands constituting a state become submerged, as well as the case of near-submergence where an island state becomes totally uninhabitable due to sea-level rise, deserves to be dealt with separately. According to general international law, a defined territory and a people are the essential components of a state, together with a sovereign government.[29] Thus, the permanent fixing of baselines would make no sense if the state itself should cease to exist due to the loss of population or land territory. On the other hand, if the state should continue to exist somewhere else, permanent fixing of baselines *before* the submergence or near-submergence would enable that state to continue to exercise its sovereignty or sovereign rights over the maritime zones and the resources therein. This would include the continental shelf up to 200 miles from the original baseline, as well as the extended continental shelf, should that state have permanently established its outer limits in accordance with Article 76 of the LOS Convention.

At least three options are available for an island state to pursue in order to preserve its rights over the maritime areas it has secured by fixing their limits permanently. First, the island state may obtain a portion of territory from another state, to which the government and population of the former migrate, thereby continuing its status as an independent state. This could be done, for instance, through a treaty of cession or purchase.[30] That would be a best solution for the island state. In practice, however, it seems rather unrealistic today to expect any state to donate or sell part of its territory to another state to be used as the new territory of the latter.

Secondly, it is possible – at least in theory – for a submerged island state to be recognised by the international community as an international person

---

[29] R. Jennings and A. Watts (eds), *Oppenheim's International Law*, 9th edn (London and New York: Longman, 1996), Vol. I, pp. 121–122.

[30] See Soons, 'The Effect of a Rising Sea Level Rise', p. 230.

sui generis and maintain its right to exercise sovereignty or sovereign rights over the maritime areas.[31] Obviously, in such a case, the government together with the population must have been migrated into the territory of another state, albeit without keeping its complete independence as a state. Although the Royal Order of Malta[32] was mentioned as an example,[33] it seems hardly possible for an international person with no defined territory or population actually to exercise sovereignty or sovereign rights over maritime areas.

A third option, which would appear to be the best solution, is for the island state, through a treaty, to establish a fusion with another state,[34] or form some kind of federation with another state,[35] whereby its entire population migrates into the new territory. Arrangements should be made for the newly united state to become the successor to the island state. Depending upon the terms of the treaty, the rights over the submerged maritime areas would be exercised either by the central government of the union or federation, or by the government of the former island state which has now become a component of the union or federation.

PROCEDURAL OPTIONS FOR ADOPTION OF NEW RULES

It was concluded above that the best general legal approach for mitigating the effects of sea-level rise is for the international community to adopt new rules which would permit permanently fixing the baselines and outer limits of various maritime zones as established by the coastal state in accordance with the LOS Convention. This section examines what options are available as a procedure for adopting or establishing such new rules. Broadly speaking, such procedures can involve either the development of customary international law or the adoption of treaties. Treaties may take various forms – such as a protocol under an existing treaty, or amendments or agreements supplementary to the LOS Convention.

---

[31] Freestone and Pethick, 'Sea Level Rise and Maritime Boundaries', p. 80.

[32] The Royal Order of Malta, or the Sovereign Military Order of Malta, is a religious order engaged mainly in medical and humanitarian services and based in Rome, Italy. It has its own 'government', an independent magistracy, bilateral diplomatic relations with over 100 countries and is granted the status of permanent observer in many international organisations, such as the United Nations. The Order issues its own passports and stamps and creates public institutions, endowed with independent juridical personality. See <www.orderofmalta.org>.

[33] Freestone and Pethick, 'Sea Level Rise and Maritime Boundaries', p. 80.

[34] See ibid.

[35] Caron, 'When Law Makes Climate Change Worse', p. 650.

Development of Customary International Law

Some authors have advocated the development of customary international law as a best means to incorporate new rules on the effects of sea-level rise.[36] For this purpose, it would be necessary for coastal states concerned to maintain in practice their original baselines and outer limits of their maritime zones despite the actual rise in sea level, and to attempt to gain approval of such practice in the relevant international forums.[37] Such practice would have to become widespread and be accepted by the international community in general in the form of a legal conviction (*opinio juris*) as reflecting new rules. That in turn would normally require a considerable period of time before new rules could be established. In addition, the approach might not always be practical since by the time that a sufficient amount of state practice has accumulated, some island states may have already become submerged, or serious disputes may have arisen – thus it would be too late, even if new rules of international law could emerge.

Adoption of a Protocol to the Climate Change Convention

The Coastal Zone Management Subgroup of the IPCC proposed in 1990 to adopt a protocol to the UN Framework Convention on Climate Change, and this was supported by some authors as a useful means to incorporate new rules.[38] In accordance with Article 17, the state parties to the Convention are indeed competent to adopt a protocol – as they have done for the Kyoto Protocol – on any matter relating to the Convention, which presumably include sea-level rise. Such a protocol, however, would be a treaty legally separate from the LOS Convention; and since it would inevitably touch upon law of the sea aspects, it could introduce complicated legal relationships between the two conventions. It would therefore be best if any additional agreement relating to the LOS Convention could be negotiated within the broad framework of the Convention itself or the UN General Assembly, as discussed below.

---

[36] Soons, 'The Effect of a Rising Sea Level Rise', p. 225; Caron, 'When Law Makes Climate Change Worse', p. 651;

[37] See Soons, ibid., p. 231, who stresses the need to maintain original outer limits of maritime zones.

[38] Freestone and Pethick, 'Sea Level Rise and Maritime Boundaries', p. 76.

Modification or Expansion of the LOS Convention Provisions

The European Commission has suggested that with the projected major changes such as receding coastlines and submergence of large areas resulting in possible loss of territory, 'there might be a need to revisit existing rules of international law, particularly the Law of the Sea, as regards the resolution of territorial and border disputes'.[39] Revisiting the law of the sea may involve one of the three approaches: formal amendment of the LOS Convention provisions, their *de facto* amendment by a decision of the Meeting of States Parties to the LOS Convention, or the adoption of a supplementary agreement for the modification or implementation of its provisions.

Amendment of LOS Convention provisions

According to the established procedure under the LOS Convention,[40] any state party may, by written communication to the UN Secretary-General, propose specific amendments to its provisions and request him/her to convene a conference to consider such amendments. The Secretary-General must convene such a conference if no less than half of the states parties reply favourably within 12 months after the date of the circulation of the request.

Alternatively, a state party to the LOS Convention may propose an amendment to be adopted by the 'simplified procedure' without convening a conference, and request the Secretary-General to circulate the proposal to all states parties. If no state party has objected to the proposed amendment or to the proposal for its adoption by the simplified procedure within 12 months from the date of its circulation, the amendment is to be considered adopted.[41]

Amendments that have been adopted by the conference or the simplified procedure, and that have entered into force in accordance with these procedures, shall be binding only on those states parties which have ratified them.[42]

To date, these amendment procedures have not been used. One reason may be the importance of the fact, in the belief of the states parties, that the LOS Convention was adopted through a 'package deal', and the General Assembly's reaffirmation, repeated every year, of 'the unified character of

---

[39] *Climate Change and International Security*. Paper from the High Representative and the European Commission to the European Council, doc. S113/08, of 14 March 2008, p. 4. Available at <www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/reports/99387.pdf>.

[40] Arts 312 and 316.

[41] Art. 313.

[42] Art. 316.

the Convention and the vital importance of preserving its integrity'.[43] Any formal proposal for amendment would thus be likely to invite immediate reaction for the sake of preserving the integrity or balance achieved as a result of the package deal. Additionally, the simplified procedure would not be an attractive method, since one single party could block the whole process. Therefore we may conclude that, for dealing with the effects of sea-level rise, the formal amendment procedures of the LOS Convention are unlikely to achieve easy success.

Decisions of the Meeting of States Parties to the LOS Convention

Apart from these procedures for formal amendment, the parties to the LOS Convention have actually amended *de facto* some of its provisions through consensus decision of the Meeting of States Parties (SPLOS). This has happened on four occasions.[44] In 1995, SPLOS decided to postpone until 1 August 1996 the first election of the judges of ITLOS, which was stipulated in Article 4(3) of Annex VI to the Convention to be held 'within six months of the date of [its] entry into force'.[45] Later in the same year, SPLOS similarly postponed until March 1997 the first election of the members of CLCS, which Article 2(2) of Annex II to the Convention requires to be held 'as soon as possible but in any case within 18 months after the date of entry into force of this Convention'.[46] In 2001, SPLOS decided that the time-limit for a coastal state to make submission of its claimed limits of continental shelf beyond 200 miles to CLCS 'shall be taken as having commenced on' 13 May 1999, in derogation from the specific requirement in Article 4 of Annex II to the Convention to do so 'within 10 years of the entry into force of this Convention for that state'.[47] Lastly, in 2008, revisiting this 2001 decision, SPLOS decided that '[i]t is understood that the time period referred to in article 4 of annex II to the Convention …and [the above-mentioned 2001 decision] may be satisfied by submitting to the Secretary-General prelim-

---

[43] E. g., General Assembly resolutions 62/215, para. 2, and 63/111, para. 2.

[44] See also the discussion by T. Treves, 'The Development of the Law of the Sea since the Adoption of the UN Convention on the Law of the Sea: Achievements and Challenges for the Future', in Vidas (ed.), *Law, Technology and Science for Oceans in Globalisation*, pp. 41–58, especially at pp. 49–51.

[45] *Report of the Meeting of States Parties*, doc. SPLOS/3 (1995), para. 16. The last day 'within six months' was 16 May 1995.

[46] *Report of the Third Meeting of States Parties*, doc. SPLOS/5 (1996), para. 20. The last day of 'the 18 months' was 16 May 1996.

[47] SPLOS, *Decision regarding the date of commencement of the ten-year period for making submission to the Commission on the Limits of the Continental Shelf set out in article 4 of Annex II to the United Nations Convention on the Law of the Sea*, doc. SPLOS/72 (2001).

inary information indicative of the outer limits of the continental shelf… and a description of the status of preparation and intended date of making a submission'.[48]

As regards these four decisions of SPLOS, there was no agreement among states parties or among commentators as to their legal nature, particularly whether they were amendments or 'understanding' of the specific provisions of the LOS Convention.[49] It is evident, however, that they do have the legal effect of changing the clear letters of the relevant provisions. Nevertheless, it is also evident that such changes involve only those provisions which relate to certain time-limits for states parties to take action. These provisions are certainly not comparable with the provisions relating to baselines and status of islands, which are designed to lay down substantive rules affecting, *inter alia,* the exercise of sovereignty or sovereign rights of coastal states.

Whether SPLOS is legally competent to deal with such issues of substance will be further discussed below, together with other possible forums for negotiating and adopting an agreement supplementing the LOS Convention.

Agreements supplementary to the LOS Convention

Agreements aimed at supplementing, interpreting or implementing the LOS Convention may be negotiated and adopted in various forums. The main forum could be a meeting of its parties, but a diplomatic conference open to all interested states, or the UN General Assembly, could also adopt such agreements.

---

[48] SPLOS, *Decision regarding the workload of the Commission on the Limits of the Continental Shelf and the ability of States, particularly developing States, to fulfill the requirements of article 4 of annex II to the United Nations Convention on the Law of the Sea, as well as the decision contained in SPLOS/72, paragraph (a)*, doc. SPLOS/183 (2008), para. 1(a). See an overview in D. Vidas, 'A Note on Submissions and Preliminary Information on the Continental Shelf Beyond 200 Nautical Miles', in Vidas (ed.), *Law, Technology and Science for Oceans in Globalisation*, pp. 423–427.

[49] For detailed analysis of these decisions, see A.G. Oude Elferink, 'Reviewing the Implementation of the LOS Convention: the Role of the United Nations General Assembly and the Meeting of States Parties', in A.G. Oude Elferink and D.R. Rothwell (eds), *Ocean Management in the 21st Century: Institutional Frameworks and Responses* (Leiden: Martinus Nijhoff, 2004), p. 295; T. Treves, 'The General Assembly and the Meeting of States Parties in the Implementation of the LOS Convention', in A.G. Oude Elferink (ed.), *Stability and Change in the Law of the Sea: The Role of the LOS Convention* (Leiden: Martinus Nijhoff, 2005), p. 55; A.G. Oude Elferink, 'Meeting of States Parties to the UN Law of the Sea Convention', IJMCL, Vol. 23, 2008, p. 769.

First, can SPLOS, which has already adopted certain decisions that *de facto* modify some of the LOS Convention provisions as discussed above, serve as a forum for negotiating a supplementary agreement? The Convention has no provisions regarding the adoption of agreements or protocols. It is generally understood that under Article 319, SPLOS meetings are convened by the UN Secretary-General only 'in accordance with the Convention', and the Convention has specifically assigned to such meetings the tasks for electing members of ITLOS and CLCS, as well as administrative and financial matters of these institutions.[50] States parties appear to be divided on whether SPLOS has the mandate to deal with matters of a substantive nature relating to the implementation of the Convention,[51] which would presumably include the adoption of a protocol or similar agreement. Since SPLOS is a body consisting of all the parties to the Convention, however, there should be no legal obstacle for it to decide, particularly by consensus, to convene an *ad hoc* conference of parties specifically to negotiate and adopt a protocol or other agreement for the interpretation or implementation of, or for supplementing, provisions of the Convention.[52] After a thorough analysis of various amendment procedures under the Convention, Freestone and Oude Elferink conclude that 'international law does not preclude state parties to a treaty amending it by agreement', and that 'such an agreement may presumably take the form of a decision of a meeting of states parties'.[53]

Secondly, a conference may be convened, typically by the UN General Assembly, to which all interested states, including non-parties, are invited, in order to negotiate and adopt an agreement relating to the LOS Convention. This is the procedure that was actually followed when the UN Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks was convened and adopted the 1995 Agreement for the Implementation of the Provisions of the LOS Convention relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (UN Fish Stocks Agreement). The Agreement does not amend the provisions of the LOS Convention, but

---

[50] See, e.g., Annex II, Art. 2; Annex IV, Arts 4, 18 and 19.

[51] *Report of the eighteenth Meeting of States Parties, 13–20 June 2008*, doc. SPLOS/184, para. 118.

[52] The parties must, however, respect Art. 311(3), which provides *inter alia* that such agreements shall not relate to a provision derogation from which is incompatible with the effective execution of the object and purpose of the Convention, and that they shall not affect the application of the basic principles embodied therein.

[53] D. Freestone and A.G. Oude Elferink, 'Flexibility and Innovation in the Law of the Sea – Will the LOS Convention Amendment Procedures Ever be Used?', in Oude Elferink (ed.), *Stability and Change in the Law of the Sea*, p. 209.

supplements and expands them with detailed rules and strengthens the basic principles.[54] One advantage of this option is the possibility for the conference to include as full participants not only the parties but also non-parties to the LOS Convention.

Thirdly, the UN General Assembly itself may adopt the text of an agreement after it has been negotiated in a subsidiary forum like a special committee or working group, or in another body or informal consultations outside the Assembly. Once the text of the agreement has been completed by such a forum, it is then submitted to the General Assembly, normally in the form of an annex to a draft resolution. In such resolution, the Assembly typically recommends member states to sign and ratify the agreement. This is the formula followed by the Assembly when it adopted the 1994 Agreement relating to the Implementation of Part XI of the LOS Convention, the text of which had been negotiated in informal consultations convened at the initiative of the Secretary-General. Although in its title the Agreement purports to 'implement' Part XI provisions, in fact it contains several provisions that drastically change them, including the suspension of their application. This process was unique in that all substantive negotiations were conducted in informal meetings, which enabled any interested states to participate in the actual re-negotiation of formally adopted provisions without forcing committed states to lose face. Another important factor contributing to the successful *de facto* revision of the LOS Convention was the fact that unforeseen, fundamental changes in political and economic situations had occurred since the adoption of its text some ten years earlier.

CONCLUSIONS

Various measures are being taken or contemplated by coastal states in order to cope with sea-level rise, which is already underway or about to happen. Such measures are mostly physical, and can never be a long-lasting solution for those coastal areas or small islands which would be seriously affected. Although limited to the questions of baselines and maritime boundaries, the new legal rules discussed above, which would involve freezing the baselines and boundaries now permitted under the LOS Convention, would enable the affected states to maintain, despite future sea-level rise, their rights over the maritime zones they have legally established.

---

[54] See M. Hayashi, 'The 1995 Agreement on the Conservation and Management of Straddling and Highly Migratory Fish Stocks: Significance to the Law of the Sea Convention', *Ocean and Coastal Management*, Vol. 29, 1995, p. 51.

Three possible approaches for adopting such new rules have been discussed in this chapter. The best approach is clearly the modification or expansion of LOS Convention provisions. For that purpose, three possible procedures have been identified. All such procedures are available, together with the combination of their various elements, for negotiating an agreement on sea-level rise. The first procedure – a meeting or conference of the states parties to the LOS Convention – appears clearly preferable, should it become possible for its non-parties, particularly the USA, to accede to the Convention, or for the conference to find a way to allow their *de facto* full participation. Unless that possibility can be realised, the second procedure – a conference open for full participation of all interested states to negotiate and adopt an agreement – would be more appropriate. The third procedure – adoption of an agreement by the UN General Assembly after negotiation in its subsidiary bodies or informal consultations – also appears attractive, since sea-level rise may be considered to be a fundamental change of circumstances like the one that prompted the re-negotiation of Part XI of the LOS Convention. Informal consultations would be particularly useful if a future agreement on sea-level rise is aimed at *de facto* revising some of the provisions of the LOS Convention, since revision or amendment would be too delicate an issue to raise at formal meetings, and might entail the risk of re-opening negotiations on other provisions.