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Editors

Macro-engineering Seawater in Unique Environments

Arid Lowlands and Water Bodies Rehabilitation

Springer

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This book is not dedicated to those complaining about the wind neither to those expecting it to change but to those who adjust the sails.

Foreword

Humans have for long had an impact on their environment. Very often the impacts were accidental and unintended consequences of human action—for example, vegetation loss due to fires getting out of control, or soil erosion produced by vegetation removal. However, as technological power developed humans have been capable of an increasing range of deliberate modifications of the environment as is made evident when one considers such features as the polders of the Netherlands, the huge irrigation systems of northern India, or the great levees of the Mississippi River. Today as our technological power increases still further, but also because our natural resources (such as water and fuel) are under increasing pressure, and because we are having a range of increasingly deleterious environmental impacts (such as climate change) that need to be halted or reversed, there is an opportunity and need to consider, in an imaginative and innovative way, possible means by which deliberate environmental modifications can be achieved by macro-engineering schemes.

One area of particular recent concern has been the application of geo-engineering to help cope with the threat of climate change. Suggested techniques have included changing the planetary albedo to reflect incoming solar radiation, the planting of huge plantations to sequester carbon dioxide, the fertilization of the oceans with iron, nitrates or phosphates to encourage the growth of marine organisms whose carbonate skeleton will then fall to the ocean floor, the pumping of cold nutrient-rich ocean water upwards to encourage algal blooms that would serve to pump down CO_2, the production of a human volcano by injecting sulfate aerosols into the atmosphere, and the placing of solar reflectors into the atmosphere.

However, an area where there may be scope for macro-engineering activities is in the world's drylands. These are important regions in terms of the proportion they make up of the Earth's land surface (somewhere between 30 and 40%), and the number of people who inhabit them (perhaps 2 billion). Some proposed schemes to ameliorate the severity of dryland climates by flooding lake basins have a long history. In the 1920s for example, Schwarcz proposed that the climate of southern Africa could be improved if the Kalahari basin were flooded. Similarly the possibility of linking those desert basins with have their floors below sea-level to the oceans in order to generate power was proposed for the Qattara basin in Egypt by John Ball at much the same time.

One of the big problems of arid lands is salinity. Natural levels of salinity are often high, but they are currently being enhanced by such processes the spread of irrigation and the removal of native vegetation. Another environment where salt poses a problem is in the oceans. Here also there are possibilities for schemes that control currents, permit desalination, provide protection against storm surges, and enable modification of sea water chemistry.

The case studies presented in this book provide an exciting range of possibilities, though, as always, one needs to be aware that macro-engineering schemes will in all probability have a range of unexpected and unwelcome environmental consequences. In addition they should not be used in the place of efforts to reduce carbon emissions, to conserve water, and to limit our energy consumption. Moreover, because of their huge costs, potential global impacts and great areal extent, they are bound to require a large degree of international collaboration. Institutions do not yet exist with the expertise or authority to assess or enforce responsible use of the global conmons and of macro-engineering techniques. Notwithstanding these serious caveats it may be time to re-evaluate the importance and feasibility of macro-engineering schemes.

Oxford, UK, June 2010 Andrew Goudie

Preface

As professionalized, practising macro-engineers, we assert the emerging key-factor of our complex world's future geo-economic development success equation must consist of macro-project proposals that become widely recognized, generously explored and soundly implemented. For continued and increasing sustainable human survival and prosperity, the existing Earth-biosphere and our Earth-world's seven billion living persons must, ever more frequently, utilize financially feasible macro-projects, vetted environmentally and made implemental by established and organized macro-engineering, simply because both realms (i.e., the Earth-biosphere and Earth's anthropocentric zone) nearly overlap in duties and tangible results.

In other words, herein, we assume macro-engineering to be a needed and wanted geosozology tool that humankind has employed anciently and recently, and will continue to employ as long as our species exists, to protect conservatively and to save (preserve) the whole Earth. Interestingly, during the late twentieth century and early twenty-first century, the technical means by which geoscientists approach the exploration and exploitation of our world's ocean and the nearest region outer space enveloping Earth have tended to mesh synergistically, especially with the development of grand networks of monitoring systems (various orbiting satellites and seabed, deep-sea and ocean–atmosphere interface sensors). Geoscientists have discovered that coastal groundwater, which once flowed into the ocean unseen, is being depleted by growing human populations resident on the world's coastline. Indeed, dammed reservoirs have, since circa 1900, reduced the world-ocean's rise by $\sim$30 mm—in other words, retarding global sea-level rise. Mirroring aircraft contrails in the sky over the ocean, bottom trawler trails rapidly gouged into the seabed by moving ships are visible in images garnered by Earth-orbiting satellites; in 2005, the General Fisheries Commission for the Mediterranean banned trawling in that segment of the world-ocean below depths of 1000 m because it is likely that unknown, possibly valuable, undersea ecosystems were being damaged as well as sunken historical time-capsules. Sound generated by shipping following heavily used sea-lanes is known to adversely affect marine mammals and air pollution emitted by ships affects human health (in seaports) and adds contaminating fallout materials to the turbulent seawater.

Swimming marine life, rivaling the seawater stirring caused by global winds, is now proved to mix the ocean fluid on a spatially large scale. The editors surmise that today's "fish mega-shoals" may one day be equaled in their churning of seawater by awesome man-made machines, big and numerous operational artifacts such as huge future Mega-Float mobile artificial islands, existing shipping fleets and future gigantic super-ships with many exterior motor-pods and even, perhaps, future vast multi-unit sailing wind-power farms. Such technology-induced seawater turbulence could affect any future human choices and internationalized establishment of particular pelagic protection regions; indeed, high-seas "Ocean Parks" may already be infeasible for the conservation of marine species because the habitat is open to unlimited seawater transformation caused by worldwide shipping, the cheapest of all means of cargo and passenger transportation.

Plastic trash dumped into the ocean releases hazardous chemicals, such as bisphenol A (BPA) and PS oligomer, upon natural decomposition; such pollutants disrupt the functioning of hormones in impinged animals, affecting their reproduction. Yet, during 2010, industrialized coast-sited aquaculture produced about 50% of the total fish and shellfish consumed by Earth's humans; commercial high-seas aquaculture is still being tested and developed for further widespread oceanic deployment. Coastal seawater bodies and the underlying seafloor, exploited by humans for tens of thousands of years, will probably be ever more intensively exploited during the coming 90 years of the twenty-first century. Noteworthy for our textbook's macro-engineering purposes, of the 2010 United Nations Organization-recognized 192 countries, there are 33 ecosystem-nations with land below current global sea-level.

Nowadays ecosystem-nations must strive to preserve visible coastal seascapes from intrusive floating billboards towed offshore by tugboats. Semi-enclosed marine systems everywhere are formed by the combination of coastal seawater bodies and river catchments on the bordering world-ocean land. Soon, fish resources and dissolved oxygen may become anthropically regulated in both watery segments. Sometimes, in circumstances of unusual and special geophysical and societal conditions such as those present in the Netherlands and at Hong Kong, China, freshwater reservoirs have been created by closing off from the world-ocean a suitable large bay or several strategic gulfs and coves. In those specific instances an ocean segment has been replaced by river or pipeline reservoir. "Coastal Zone Management" has economic costs, of course, as with the prevalent early decade of the twenty-first century global economic malaise and yet, so far, "the end of the world" phrase cheekily applies accurately only to a temporarily halted commercial macro-project in Dubai, "The World" collection of artificial islands in the Red Sea.

Herein, we treat many unique facets—potential factors in the postulated equation of widespread human land-ocean usage—of our world's present-day macro-engineered and to-be-macro-engineered coastlines. By 2050, our Earth's human population is predicted to exceed 9 billion persons. Progressive interdisciplinary understanding of the Earth-biosphere articulates an ever-encompassing network of digitized data and enveloping idea relationships responding to human beliefs and thoughts about Earth's prospective nature-influenced future, projected food, materials and energy consumer demands, as well as superimposed natural and unnatural global change. Seawater aquaculture has, therefore, the near-term future potential of becoming the second most prolific means of food production for human consumption after the very ancient honorable activity of agriculture on land.

We view positively the macro-engineering mind-set as a social and technological enterprise and expertise that benefits humanity by permitting exceptional technological and social innovations to be explored during a period of obvious and world-public noticed Earth-biosphere changes. In short, we foresee macro-engineers as the crew, not "mere passengers", of Spaceship Earth since adaptive biosphere management on a self-altering (nature) and anthropogenically impacted terrestrial planet requires timely advancements in our understanding of Earth-surface dynamics in order to influence it in a purposeful manner, including imaginative mitigation and curative macro-engineering project proposals. The more individual persons comprehending and evaluating macro-projects, the better the chance flaws and dangers in macro-project proposals become exposed publicly and the bigger the collection of organized knowledge from which to spin-off appropriate macro-engineering solutions.

Seacoast-focused willful macro-engineers always may advance, and sometimes retreat, with a certain degree of uncertainty, not only because humanity's future and ultimate end is thankfully still undefined conceptually, but also because useful knowledge of most of the natural and social-economic oceanic and coastal processes are still, and probably will always will remain, incomplete.

So, it is our intent herein, to merely suggest, visionary mega-projection style, some technically possible new useful infrastructures, built as intriguing and attractive macro-projects in the coastal region, some of which are inland depressions and/or adjacent world-ocean arid landscapes, which can be used to adapt or to rigorously control ongoing and initiating Earth-surface geodynamical processes. Certainly beyond unnecessary pollution and contamination, the world-ocean and the coast are physically malleable and may already be trending to future abrupt, probably unpredictable, nature-instigated changes. Accordingly, we refuse to offer miniscule solutions with, and based on, our inquisitional macro-problem equation. We do support any and all expert efforts to advance the ideas and technical cures necessary for the prediction of, and adjustments to, dynamic seacoast change—the enveloping "Coastal Zone Management"—at the all-important macro-engineering scale which allow the pervasive restoration, preservation and creation of valuable and beautiful landscapes immediately adjoining the Earth's ocean.

Earth's surface material and energy disequilibrium is almost strictly a response mainly to internal radiogenic heat and external solar radiation. Soon, large-scale human exploration, exploitation and manipulative settlement activities in drylands—extraction of freshwater, food, fodder and fiber production, tapping of geothermal and solar energy resources and waste disposal will add a powerful new anthropogenic forcing additional to nature's tectonic and climatic forcings.

This book takes account of the simple fact that if the welfare of our species is to be preserved for a long time to come, macro-engineering is certain to become a more widespread profession since its practitioners are in the forefront of the remaking, unmaking and extension of our extant infrastructure. Macro-projects with a regional or global impact demand collaboration and negotiation among many participating parties. Omnipotence or omni-benevolent characteristics are not claimed by macro-engineers; we do claim that macro-engineering aims to design Earth-biosphere benignity into our spatially large-scale creations so that they can be constructed with minimal energy and raw materials, few hazardous macro-project design-life moments, and little (if any) harmful by-products and discarded waste that require costly disposal such as entombment.

The goal of this edited book is to gather together a number of macro-projects involving seawater management, arid lowlands and salt-water bodies rehabilitation, that were already studied and reported in the literature as well as new, original macro-engineering concepts. A secondary purpose of this book is to inform persons with imagination and personal drive to solve macro-problems related to humanity's striving for long-term survival, a topic of considerable interest worldwide (engineering of Earth's climate, for example). Another purpose is to provide a history of the literature related to macro-engineering, which is a purpose-driven meld of geo-engineering ideas, so that our book's readers will have a solid base upon which to commence their own life-long advancements to change for the better the inhabitable Earth-biosphere. Also, the book is intended to foster a needed professional spirit because macro-engineering's creative and scientific activity transforms global nature and can transmogrify any global nature to serve the needs and wants of large numbers of persons—we create what did not exist.

This book is structured along logical lines of progressive thought on the topic. The first part of the book contains three chapters and deals with the histories of ancient and modern use of seacoasts. After the introductory Chap. 1presenting the Earth's past global sea-level change and its connection with human settlements, the first in this series, Chap. 2, examines the prototypic history of a man-made Mediterranean Sea port's construction (Ischia Harbour in southern Italy). Chapter 3 documents ongoing anthropogenic coastal development promoted by extant great wealth, accumulated mostly since World War II, in the United Arab Emirates.

The series of informative macro-engineering thinking forming the second part of the book (Chaps. 4–7) outline possible macro-projects capable of massive changes in the coastlines of the Dead Sea, Red Sea and Persian Gulf caused by canal and massively scaled hydropower dam installations.

Part 3 is entirely focused on the Black Sea with a series of seven histories and proposals (Chaps. 8–14) which examine virtually every relevant macro-engineering aspect of that famous body of seawater known worldwide today and mentioned often in humanity's recorded history.

Part 4 is constituted of a single, yet important contribution (Chap. 15) that examines the possibility of artificially stirring a northern Europe seawater body (Baltic Sea).

Part 5 is composed of essays (Chaps. 16–18) describing the twenty-first century possibilities of refreshment of the Aral Sea and Iran's Lake Uremia with seawater or river freshwater importation macro-projects.

Part 6, a series of three statements (Chaps. 19–21), are strictly focused on the potential rehabilitation of some vital arid zone regions now dominated by moving or movable surface granular materials using unique and unusual macro-projects. These offered installations, however, are preceded by a biographical story of a pioneer of sand movement understanding (Ralph Bagnold).

Part 7 deals with the seawater flooding of land regions situated below present-day global sea-level. A series, consisting of four inspiring articles (Chaps. 22–25) soundly document the difficulties, and probable rewards, of submerging some near-coast wastelands.

Part 8, is a five-part series (Chaps. 26–30) devoted entirely to harnessing energy and obtaining freshwater from the world's salt-laden ocean by various modern industrial means.

Part 9 (Chaps. 31–33) address various macro-projects designed specifically for the protection (reduction of vulnerability) of particular Earth geographical regions.

More details about the 33 chapters of the book are given below.

Chapter 1, by Geoffrey N. Bailey and Geoffrey C.P. King, shows that for most of human existence on the Earth over the past 2 million years, sea levels have oscillated with amplitude of more than 100 m in response to the expansion and contraction of the continental ice sheets. At the termination of the most recent Ice Age, global sea level rose from a low-stand of −130 m (about 16,000 years ago) to reach its modern-day level about 6,000 years ago. Vertical changes of this scale have been a continuous accompaniment to the growth and expansion of human societies throughout pre-history, creating profound changes to the landscapes in which people made and earned their livings. Alongside these effects in coastal regions, tectonic changes associated with tectonic plate motions, Earth-crust rifting, earthquakes and volcanic activity have produced equally profound changes of the physical landscape in many of our world's regions. Paradoxically, these regions of geological instability and dynamic landscape change appear to have attracted concentrations of human populations from the earliest period of our history as a biological species. One explores the geophysical processes associated with these changes and their effects on past human societies. One shows that these dynamic processes of geological change, although they can have destructive consequences in the short term, often create and sustain a complex topography with attractive ecological conditions for human settlement and may have exercised powerful selection pressures in favour of the human evolutionary trajectory. One shows how a long-term perspective made possible by an archaeological focus on human-landscape interactions can help to shed new light on the nature of the physical changes themselves, unravel the way in which different sorts of processes operating on different time scales interact, and provide insights into the likely longer term consequences of our present-day and future actions.

Chapter 2 authored by Stefano Carlino, Elena Cubellis, Ilia Delizia and Giuseppe Luongo examines recent and historical sources with a view to reconstructing the circumstances leading in 1854 to the opening of the natural harbour of Ischia, the execution phases of the works and the morphological changes arising.

An active volcanic island, Ischia has since the late seventeenth century been a major European destination for spa treatment. It underwent a period of change after the harbour was opened up, which represented not only an outlet towards the mainland but also an important factor of social and cultural aggregation for the island. The historical analysis is followed by the description of the geology of Ischia Harbour and by observations of the current state of the island as well as the main issues concerning the increase in volcanic and seismic risk resulting from urban expansion and the increase in tourism since the first half of the twentieth century. Some of the well-known risks to the people of Naples from Vesuvius are comparable with the risks all of the permanent residents of Ischia must endure.

Chapter 3, penned by Pernilla Ouis explores the recent development in the United Arab Emirates regarding the creation of artificial islands and other mega development projects on islands. This development is discussed in terms of a recent “islomania” in the region, as a part of the strategy to diversify the economy towards tourism and international finance. Luxury housing, luxurious hotels, constructed beaches, and facilities for amusement and leisure are constructed on such man-made isolated places which are interestingly exemplified with the world-famous artificial archipelago “The World” and the three Palm islands in Dubai and the reclamation of Saadiyat and Sowwah Island in Abu Dhabi, and similar macro-projects. These islands can be seen as important urban flagships for the country on the global tourism and financial industries market, but also as cultural icons legitimizing modernity with reference to tradition. Hybrid urbanism is discussed, arguing that the islands create segregation rather than promoting a cultural and social mix. The islands are interpreted as colonial, utopian spaces for the global elite. Further, the artificial islands create an inversion between the map and nature. Such islands are important symbols viewed from aircraft and from Earth-orbit, and a new kind of tourist, the Google Earth tourist, is identified. Ecological as well as economic sustainability issues are discussed in terms of economic dependency, and hence vulnerability even in the alleged post-oil era.

Chapter 4 by Shahrazad Abu Ghazleh, Abed-Alqader Abed and Stephen Kempe shows that the Dead Sea (DS) is a hyper-saline lake occupying one of a series of pull apart-basins formed in the Earth-crust along the Dead Sea Transform Fault. It represents the lowest terrestrial point with a briny water level of 422 m b.s.l (as of June, 2009). Since 1932, the lake level has experienced a dramatic drop amounting to 0.4 m/a on average due to the accelerating freshwater consumption in the DS Basin. The analysis of the terrain model of the DS and shoreline altimetry shows that the Dead Sea has dropped vertically by 1 m/a during the last 14 years and lost 0.65 km^3/a and 4.6 km^2 from its volume and area, respectively. The polynomial function derived from the terrain model used can predict the near-future changes in the lake’s volume and area. Therefore, in 2020, the lake is expected to lose 7.7 km^2 and 50.6 km^2/a from its current volume and area, respectively. The continuous decline of the DS level caused severe environmental consequences for the lake and for its surroundings, threatening the limited natural resources and the natural habitat of the area. Although the rehabilitation of the Jordan River is the safest ecological alternative for maintaining the DS and the river flow, it would not solve the macro-problem entirely however. The Red-Dead Canal seems to be a sustainable long-term alternative with several attractive benefits for the riparian countries. The volume-level model and the previous investigations of the groundwater discharge and evaporation rate from the salt-ponds suggests that the projected Red-Dead Canal must have a carrying capacity of 1.5 km^3/a in order to halt lake level decrease (stabilization). The canal will also utilize the altitude difference of $\sim$400 m to generate hydropower and produce freshwater by desalinization. Moreover, such a canal will maintain tourism and the profitable potash industry of the Dead Sea and reduce the natural hazard caused by the lake's shoreline advance. The possible environmental impacts of the canal could be minimized or avoided using a comprehensive plan of environmental hazards assessment and mitigation.

Chapter 5 by Damien Closson, Herbert Hansen, François Halgand, Nada Milisavljevic, Frédéric Hallot and Marc Acheroy refers to the Red Sea-Dead Sea canal, showing the origins of this project and the challenges it faces. The opening segment of the chapter deals with the freshwater shortage problem in Jordan, Israel and Palestine. The information is taken from pioneering studies which were conducted during the 1990s. Once the general background for understanding the issues behind the need for the Red Sea-Dead Sea Canal has been drawn, a comprehensive technical description of the macro-project's major physical elements is provided on the basis of a pre-feasibility study conducted in the mid-1990s. The work of the feasibility study for the canal project is then presented. It started only six months before the writing of this chapter and will last approximately one year and a half, perhaps until 2012–2013. This part enumerates the major geological and engineering challenges that will require complete technical answers.

Chapter 6 by Roelof Dirk Schuiling, Viorel Badescu, Richard B. Cathcart, Jihan Seoud and Jaapchan C. Hanekamp shows that artificial closure of the Red Sea at its southern entrance (the Bab-al-Mandab Strait) could well lead to the world's largest hydropower generation, of the order of 50,000 MW. The cost and time-scales involved are, obviously, beyond normal twenty-first century economical considerations. Macro-engineering projects of this size cause a massive destruction of existing ecologies. On the positive side of the environmental assessment scale, however, are the vast reductions of aerial greenhouse gas emissions, and the reduced pace of exhaustion of mined fossil hydrocarbon resources. This chapter examines the ethical and environmental dilemmas and some of the political implications of macro-engineering, as exemplified by the Bab-al-Mandab Macro-project.

Chapter 7 by Roelof Dirk Schuiling, Viorel Badescu, Richard B. Cathcart and Piet van Overveld shows that compartmented ocean gulfs offer a means of artificially creating a water depression, which can be used for a regionally significant hydroelectric macro-project. One examines the case for a dam at the Strait of Hormuz that blocks a large gulf situated in an arid region. A 35 m evaporation of this concentration basin will reduce its seawater surface area by 53% and allow generation of 2,050 MW (or possibly 2,500 MW) of electricity. The conclusion is that the proposed Electricity Development Infrastructure Node (EDIN), echoing the Biblical Eden, is a feasible and desirable macro-project. If the macro-project starts in the near-term future, it would require a significant change in the logistics of oil and gas transport from this region. Alternatively, it can be considered as an attractive future solution for the energy requirements of the region after exhaustion of its underground oil and gas reserves.

Chapter 8 by Yukinobu Oda, Kazunori Ito, Takahide Honda and Solomon Yim discusses construction techniques for deep-water an immersed tunnel under strong seawater current conditions. The Bosphorus Tube Tunnel, submerged beneath the heavily trafficked Bosphorus Strait, a part of the upgraded railroad system in Istanbul, Turkey (the Marmaray Project), is constructed using the tunnel element immersed method. The maximum installation depth of 60 m makes it for the time being the world's deepest immersed tunnel. The Bosphorus Strait is very narrow horizontally and winding, akin to some rivers on land. The seawater current speed changes rapidly and sometimes runs >2 m/s. To overcome such severe current conditions various techniques have been applied. Some of those are reported here. In particular, a seawater current forecast system, developed to maintain quality and safety of tunnel construction, is presented and discussed. The flow of the Bosphorus Strait changes under the influence of not tide but, rather, ambient weather conditions, mainly air-pressure and wind. The forecast system estimates the seawater levels at both ends of the strait on the basis of weather information and predicts the seawater current by taking the density interface effect into account. The predictive model is statistically developed based on a year-long observation data set. The current forecast gives sufficiently accurate information for the everyday marine construction operation.

Chapter 9 by Mircea Dimitrie Cazacu and Sergiu Nicolaie presents relevant research of a joint effort by the Power Engineering Faculty from Politehnica University Bucharest and the National Research Institute in Electrical Engineering, also from Bucharest. In the first part one presents the contributions of theoretical and experimental researches, concerning the viscous fluid flow through the axial rotors of hydraulic and wind turbo machines, by approaching aspects regarding the novelty of the mathematical apparatus (the method of maximal power extracted from the kinetic energy of current fluid flow for turbines) and, also, the special technical applications obtained (e.g., lighting buoys with energetic autonomy on rivers). Also one presents the experimental tests and by validating the previous values obtained in theoretical way, for the both axial rotors (with three and four blades). The tests were performed on a glassed-in hydrostatic channel, and also in a small open wind stand, obtaining a maximal power coefficient CP = 0.56. In the second part of the chapter the author-team presents relevant research related with Ecological River traffic in the biosphere reservation of the Danube River Delta, using electric boats based on renewable energies. Related with this application they present the method to obtain the maximal propulsion force for the propeller of the boat.

Chapter 10 by Eugen Rusu refers to the implementation of the spectral phase averaging models in the Black Sea and to the usage of the wave prediction system developed in two important directions. These are to evaluate the wave energy resources and the most relevant interactions that may occur between sea-waves and seawater currents. The study is focused on the western part of the sea which is traditionally considered as being more energetic. The wave prediction system implemented for the Black Sea is based entirely on the SWAN model (acronym for Simulating WAves Nearshore), which is used both for wave generation and nearshore transformation. This methodology has the advantage that a single model covers the full scale of the modeling process. Various tests were performed considering data measured at three different locations. Special attention was paid to the white-capping sea-wave process that is still widely considered the weak link in deep-water wave models. Comparisons carried out against measured data show that the wave prediction system generally provides reliable results, especially in terms of significant sea-wave heights and mean periods. After the model system calibration by increasing the resolution in geographical space, the field distributions of wave energy were analyzed for both high and average sea-wave conditions. The second application of the wave prediction system is related with the evaluation of the wave current interactions at the entrance of the Danube Delta. The wave conditions in this coastal sector are usually significant from energetic point of view and relatively strong currents, induced there by the Danube River outflow, lead to interactions between waves and currents. This process modifies considerably both sea-waves' magnitude and direction affecting also the coastal navigation and the sediment transport patterns. Five case studies corresponding to the most relevant patterns of the environmental matrix were analyzed. Finally, in order to assess the current effect for a longer time scale an analysis concerning the variation of the main wave parameters was performed for a three-month period considering some reference points. The results show that the currents produce considerable changes in the wave field especially as regards the significant wave heights, mean wave directions and wavelengths. The Benjamin-Feir Index was also estimated. The analysis of the variation induced by the current over this spectral shape parameter indicates that, in certain conditions in the target area the sea-wave heights can not be considered Rayleigh distributed and freak waves may also occur.

Chapter 11 by Mircea Dimitrie Cazacu and Dan Aurel Machita shows that considering the velocity potential expression, corresponding to Gerstner's traveller wave motion, one obtains the relation that gives the value of the constant C, determined by applying of Daniel Bernoulli's relation on the wave free surface, for a same time moment, as function of wave height. One determines the link between the wave kinetic parameters and water mean deep in the conveying channel, to obtain the real values of this constant. Developing the multiple utilities idea for the hydropower arrangements, introduced in Romania by the famous Romanian scientist, professor and engineer Dorin Pavel (1900–1979), they present in this chapter a special hydro-energetic building, placed in front of the Black Sea shoreline at the submarine isobaths between 4 and 10 m, which realizes the following utilities: (i) captation of nonpolluted and inexhaustible sea-wave energy, which on the short Romanian littoral of $\sim$200 km has the same size order as that of the state's interior river potential energy, (ii) shore protection against destructive sea-wave action in the conditions of diminishing of Danube River alluvium transport, as a result of the extant hydropower dams inland and of dispositions to struggle against inland soil erosions, (iii) captation of nonpolluted and inexhaustible energy of wind, by laying a row of wind turbines atop the proposed Sea Highway macro-project, (iv) high speed sea link by means of the slider ships on air cushion in this near-shore zone without large sea-waves, between the littoral and the energy collectors captation devices, (v) terrestrial high-speed transport on this Sea Highway parallel to the litorral, (vi) transport of gaseous or liquid hydrocarbons by pipelines mounted atop and/or within the Sea Highway infrastructure.

Chapter 12 by Roelof Dirk Schuiling shows that metal wastes are produced in large quantities by a number of industries. Their disposal in isolated waste deposits is certain to cause many subsequent problems, because the sealing of disposal sites usually starts to leak, often within a short time period after the disposal site has been filled, capped and legally closed. The contained heavy metals are leached from the disposal site and will ultimately contaminate the surrounding soil profile and the groundwater. Storage as metal sulfides in an anoxic environment is the safest method to handle these detestable metal wastes. It is proposed to use the world's largest anoxic basin of seawater, the Black Sea, as a georeactor. Metal wastes will be transformed, sustainably, into harmless and immobile sulfides, which are incorporated in the lifeless black-colored sea-bottom mud, where they are likely to be safely stored at no further economic cost for millions of years.

Chapter 13 by Mircea Dimitrie Cazacu and Raducu Viorel Iancu deals with the advantageous naturalization of the Black Sea waters. After a short history of the Black Sea is presented, different researches concerning the extraction of hydrogen sulphide in some patented methods and installations with the aim-point goal of Black Sea deep-water naturalization, because in few decades the accumulation of hydrogen sulphide will transform the place into an marine dead zone. In the frame of the patent one claims more possibilities of environment-friendly technologies, as: the energy of the emitted gases from the deep-water extraction using a turbo-exhauster, the energy due to the hydrogen sulphide burning using a hot gas turbine, as well as the production of the high purity sulphuric acid and also of the deuterium, necessary to the heavy water fabrication in the present atomic epoch and for the producing of the future energy by deuterium fusion reaction. The advantages of the proposed original method and installation for the naturalization of the deep water of freshwater lakes, seas or oceans are as follows: (a) the easy progressive starting of the accelerated unsteady flow of the biphasic fluid from the vertical pipe of very great length, (b) the elimination of the eruptive dangerous phenomenon, created by the accelerated lifting of the gas bubbles by their expansion in the vertical pipe, (c) the deposition of the water without dissolved gases in a superior reservoir, from where these (maybe afterwards) could be restored periodically to the Black Sea, (d) the utilization of the compressed gases detention energy by their elimination from the deep water, (e) the use of energy, given by the hydrogen sulfide burning, through a turbo exhauster, (f) the utilization of the eliminated gases from the deep-water by sulfuric acid production and (g) the eventual separation of the deuterium contained in the deep-sea waters and the gases from depth, necessary for the present heavy-water production and for the anticipated future sustained fusion nuclear reactors generating electrical power.

Chapter 14 by Salah Naman, Engin Ture and Nejat Veziroglu refers to an industrial extraction pilot-plant for stripping H_2S gas from Black Sea water. The results from the laboratory scale extraction pilot-plant unit for the separation of H_2S gas from Black Sea seawater led the authors to build a novel industrial extraction pilot-plant to concentrate H_2S gas from 10 ppm concentration to above 10,000 ppm concentration. A technology for extraction and concentration of H_2S gas is essential. The conceptual pilot-plant proposed in this chapter is, in principle, similar to the laboratory pilot-plant developed at the University of Duhok (Iraq), and it could work to pump seawater directly from Black Sea. It contains a screen with electrical heater to fix the temperature of stripping, a water chiller at the top to separate any water droplet or vapor. The research on industrial pilot-plant has shown that, this unit could operate both on as well as underneath the Black Sea's surface.

Chapter 15 by Anders Stigebrandt and Bengt Liljebladh shows that, in the future, it might be interesting to oxygenate large natural seawater basins for different reasons such as nutrient management or promotion of preferred ecological states. Before such enterprises in mega-engineering should be undertaken, the basin's biogeochemical and ecological response upon oxygenation must be well characterized. The present chapter describes an experiment in the seawater of Byfjorden fjord located on Sweden's West Coast which has restricted exchange due to a submarine sill. The basin usually contains high concentrations of hydrogen sulfide but during the experiment it will be kept oxic by pumping down oxygenated surface seawater into the lowest part of the marine geologic basin. This may improve the oxygen conditions in the basin in two ways—by direct addition of 02-saturated seawater and by decreasing the density of the basin's seawater which will increase the frequency of exchange with the marine area outside the fjord and, thus, bring more water (and oxygen) into the basin. The authors develop a model that computes the evolution of the oxygen concentration in similar isolated basins when adding a flow of surface seawater. Knowing the rate of oxygen consumption, the model may be used to estimate the required pump capacity to obtain specified oxygen conditions in a wide range of marine basins.

Chapter 16 by Richard B. Cathcart and Viorel Badescu proposes a comprehensive control strategy to partially recreate the Aral Sea which directly involves several hydrological factors: (i) overland pipeline conveyance of Caspian Sea water deposited into the Aral Sea Basin; (ii) overland pipeline conveyance of Aral Sea brine deposited into the Caspian Sea and (iii) compensating overland pipeline importation of Black Sea water to the Caspian Sea. Effects of hydrological management of the Syr Darya and the Aral Sea's regulated Western Basin as well as a technical/economic model are offered. Three operational scenarios produce water levels stabilized at 28.9, 27.2 and 25.7 m, respectively. A macro-engineering solution is considered. Increased runoff from Syr Darya and other freshwater sources raises the Aral Sea level by 1.4–3.5 m. Depending on the scenario, the Aral

Sea returns to its 2005 elevation. Caspian Sea water importation, at flow rates of 14 km^3/year leads to Aral Sea stabilization at $\sim$32 m. Some considerations of the macro-project's ecological, cultural and social consequences are examined.

Chapter 17 by Roelof Dirk Schuiling and Viorel Badescu shows that the Aral Sea has shrunk and became a large salt-pan, because the freshwater from the two rivers that used to feed the lake (Amu Darya and Syr Darya) is almost entirely used for irrigation. In this chapter some possibilities to return to the original (1960) situation are studied. After discussing some of the alternatives, it is proposed to construct a canal along a more southerly route than the original Sibaral Canal, starting from the Zaisan Lake along the Irtysh River. This solution requires the expensive construction of a major tunnel through the Khrebet Tarbagataj mountain range. Thereafter, it will flow through the Balkash Lake, saving several hundred kilometers of canal construction, and discharge its water in the lower reaches of the Syr Darya. From here it will flow into Aral Sea, slowly restoring it towards its original (1960) level. Several flanking water-saving measures are considered. Most of the drive to restore the Aral Sea is for ecological reasons. There may also be a serious climatic threat to avoid, although this is a matter of debate. It is found that the river discharge from Siberia into the Arctic Ocean is on the increase, and this may affect the great world-ocean conveyor belt. This would have dire consequences for the climate in western and northern Europe. This could be avoided by diverting part of the water towards the Aral Sea. A restoration of the Aral Sea will have beneficial effects on climate, human health, fishery and ecology in general.

Chapter 18, by Hossein Golabian, starts by showing that accelerating demand for freshwater to be used in agriculture, industry and human consumption is a global phenomenon. Pressures on freshwater sources, i.e. rivers and underground reservoirs are causing gradual but unavoidable desiccation of the endoric water bodies. Many lakes have already dried up and been converted to anthropic deserts all over the world. Many of them are in remote Earth regions and forgotten, but some other are under news spotlight. The Aral Sea is the most famous case. The next one in this series of environmental disasters is Urumia Lake in the northwest of Iran, our world's second largest salty water lake and an internationally important wetland. Urumia Lake is located in a densely populated area and contains $\sim$8 billion MT of salt and other minerals which upon drying of the lake will become a gigantic "salt bomb" owning to wind deflation and will endanger the population in an surrounding area of >500 km radius. Its salt content must be contained and this goal cannot be achieved except that the lake is kept filled by enough water. There is no other reliable, accessible, and sustainable water resource other than Caspian Sea within some 300 km distance which can act as a helping elder sister to Urumia Lake. This chapter describes the idea of supplying severely needed water quantity for the stabilization of Urumia Lake by intentional transference from the nearby Caspian Sea.

Chapter 19 by Michael Welland deals with the sediment transported by wind and moving water in arid regions, focusing on the pioneering work of Ralph Bagnold. Ralph Alger Bagnold pursued two highly distinguished careers, one military and the other scientific. His early pioneering exploratory expeditions through the Eastern Sahara demonstrated the means by which motorized travel in such landscapes could be achieved and inspired his life-long love of our world's largest desert (contiguous area). His enduring scientific legacy lies in his groundbreaking work on sediment transport by both wind and flowing water, work that began in the 1930s and continued for the rest of his life. This work, and its subsequent refinement, continues to underpin the multidisciplinary design and evaluation of essentially all macro-engineering projects. Bagnold as a scientist is difficult to categorise. He described himself as an amateur who had never held an academic position "or had any professional status." But, as he wrote in his autobiography, he felt that this gave him "the rather unusual advantage of considering problems with an open mind, unbiased by traditional textbook ideas that had remained untested against [field] facts". He was, at heart, an engineer, but one with an acute and perceptive capacity to apply other disciplines—physics, mathematics, geology—to his identification and analysis of any problem. It was Bagnold's intuitive and radical interdisciplinary approach to sediment transport activated by wind and water, over the course of more than fifty years and fifty scientific papers, that enabled today's Earth scientists and mega-project engineers to plan and pursue research and projects equipped with a deep, if still imperfect, understanding of these critical natural processes. Bagnold's classic book, The Physics of Blown Sand and Desert Dunes, continues to hold the position of the second most-cited academic publication of any kind in the field of geomorphology. And modern textbooks, at least in the Earth Sciences, will contain wording such as uttered by M.R. Leeder: "In the absence of any modern readable text solely dedicated to the principles of sediment transport, a return to Bagnold's 1954 classic (for wind) and to his 1966 (for water) should provide the necessary inspiration."

Chapter 20, by Magnus Larsson, shows that by deliberate injection of dune sand with prepared cultures of the bacterium *Bacillus pasteurii*, an aerobic bacterium pervasive in natural soil deposits, they can solidify such granular accumulations into sandstone structures. A network of such infrastructures could mitigate the threat of desertification, while providing adaptive shelter spaces from the shifting sands. Or, as characterized by a July 2010 magazine article published in Popular Science (pages 48–49), "Ecotopia" might be established in the Sahara. Discontinuous dryland regions cover more than one-third of our Earth's land surface, and desertification—"the diminution or destruction of the biological potential of the land"—is certainly a major threat to human welfare on all continents, affecting more than 100 countries in the world. Some estimates suggest that 35% of Earth's land surface, as well as the livelihoods of ~850 million people, are at risk nowadays. More than 80% of Africa's drylands are moderately or severely desertified, a figure that equals more than one-third of all desertified land in the world. Sand dunes cover only about one-fifth of our existing deserts, but those extreme regions are good places to introduce a barrier of greenery in order to halt the shifting sands and stop the dunes from migrating. The idea of a 'Green Wall for the Sahara' was first proposed by a former President of Nigeria (Olusegun Obasanjo) in 2005. The initiative originally called for twenty-three African countries to cooperate in order to plant trees across a 7,000 km by 15-km shelter belt just south of the Sahara. The macro-project presented here would turn 6,000 km of sand into a pan-African sandstone city, a linear urbanization, and support the Great Green Wall for the Sahara and Sahel Initiative through a localised cementation of the desert sand via microbe-induced carbonate precipitation (MICP). The spatial pockets would help retain scarce freshwater and mineral resources, while also serving as habitable and programmable spaces for a nodal network converging with the planned Sahara Railway. The result would be a habitable wall-like infrastructure straddling latitudinally an entire continent, binding villages, people, and ecosystem-countries together. All design is fundamentally about aggregation and erosion. One adds and one takes away. The novel process of engineered architectural lithification, creating from a pile of loose sand a solid sedimentary rock structure, a sandstone building, effectively involves gluing one grain of sand to the next on a microscopic level. The building speaks of the chronology of the sand, the vast rhythms of Earthly geological history, the evolution of human villages and burgeoning cities covered in shimmering grains, forgotten in a sea of sand.

Chapter 21 by Viorel Badescu and Richard B. Cathcart proposes macro-engineering using tactical technologies that stabilize and promote the vegetation of barren near-coast sand dune fields with imported seawater. Extracted seawater that would otherwise, as commonly postulated, increase the Earth–ocean volume. Anthropogenic saturation of the ground with pumped seawater should fix widespread active sand dune fields in deserts (such as the westernmost Sahara). Seawater extraction from the ocean, and its deposition on dune sand, is made via solar-powered pipeline. Stabilization of one major erg in Mauritania is evaluated as a pre-implementation case study. The financial cost of the macro-project is estimated as a few billion USA$—less than about 0.1% of the USA's 2010 gross domestic product (GDP). The initial investment may be between 0.6 and 1.1 billions USA$.

Chapter 22 by Nicola M. Pugno, Richard B. Cathcart and Joseph J. Friedlander proposes the connection and maintenance of an artificially created Mediterranean Sea gulf. Dug, maintained and enlarged by nuclear-powered dredgers, the CATS (Chotts Algeria-Tunisia Scheme) could, eventually, result in the development of a North Africa-version of Europe's Mainport Rotterdam. A CATS-style harbor is a sheltered part of seawater deep enough to provide anchorage for ships or a place of refuge. If built, the CATS could offer shipping some protection from both long- and short-period Mediterranean Sea waves, easy safe access to the Mediterranean Sea in all types of weather, adequate depth and maneuvering room within the CATS harbor, shelter from storm winds and minimal navigational channel maintenance dredging. Of course, the environmental impact of pollutants generated by routine shipping operations in the CATS harbor is unavoidable. The authors propose to control the Mediterranean Sea's future level rise, limiting it to just a 1-meter rise within the Basin, with a low-cost barrier at Gibraltar Strait. Simultaneously, protective infrastructure investments at Venice, Italy, and other historic locales could be stopped and funds may be diverted or partially re-directed to realization of the CATS, especially because Europe now views North Africa as a site for energy generation that can be transmitted to Europe via undersea electric cables. The authors outline, in significant economic, geographical and social details, the entire macro-engineering development process for the CATS. The history of proposals for the chotts development, including nuclear excavation, is also discussed.

Chapter 23 by Ragab A. Hafiez reveals that the Qattara Depression, in Egypt's Western Desert, is the largest land depression—located entirely below the mean global sea level—in the Eastern Sahara. In this chapter, the available SRTM-90 meter digital elevation data have been used to delineate the real periphery of the depression, to generate an accurate contour map, and to develop a new terrain model of the volume and surface area for each level of the entire Qattara Depression. Regardless of the physical and chemical factors that may affect the contained volume of imported water, at each contour level the volume is found to be increased in an ascending, but irregular, order from $<1.0\ km^3$ at the dent's floor to more than 190 km^3 near the top. The dominance of evaporites near the bottom, and fractured limestone at the top, of the depression are, also, governing factors of the arbitrary mechanically transported seawater volume. The role of such resulted inland seawater lake due to the seawater transportation in changing the local climate is expected to be considerable by the increase of relative humidity and decrease of ambient temperature. The change of the region's climate, from a hyper-arid to an arid or semi-arid climate, is expected and desirable.

Chapter 24 by Pandora Hope, Andrew B. Watkins and Robert L. Backway elucidates that drought and the growing demand for freshwater are increasing problems in many regions of the world. The extent of the regions and the number of people affected by freshwater stress is projected to increase in the twenty-first century. One proposed macro-engineered solution is the extensive flooding of key locations with seawater, with the aim to increase downwind rainfall. This chapter examines the theoretical impact, and hence potential benefit to an potential agricultural region, of such an inundation macro-project; namely the seawater flooding of Lake Eyre in central Australia and the impact this may have upon the Murray Darling Basin (MDB), which lies eastwards of Lake Eyre and is often termed Australia's 'food basket'. The first method of analysis uses periods when Lake Eyre has been naturally flooded with freshwater (it is an ephemeral lake, and often has a surface of salt crust) as a proxy for an artificial seawater inundation. An estimate of the monthly time-series of Lake Eyre water volume was created and compared with MDB rainfall. Results suggest, at best, only a small contemporaneous correlation, explaining about 10% of the variance. When Lake Eyre volume leads MDB rainfall, correlations drop close to zero. This simple analysis suggests the climate of the MDB is unlikely to be driven in any significant fashion by flooding at Lake Eyre. The second method to assess the impact of such inundation uses climate models to artificially flood Lake Eyre, and then to compare the response with identical simulations using a dry lake. Climate models for this purpose range from very high resolution, meso-scale weather models that simulate only a small region but include many surface processes, to global models that capture all the interactions with the broad-scale Earth-atmosphere circulation. In between are regional models, which can cover a broader region of interest and draw upon information provided at their boundaries. Studies using both mesoscale and regional models indicate that enhanced localized air cooling is evident in the region of an artificially flooded lake. The rainfall response however, is less clear, with regions further afield, such as the MDB relative to Lake Eyre, showing no consistent climate response. As computers become faster and computer time cheaper, higher resolution studies can be performed. Such experiments may become routine for all proposed macro-engineering projects which involve inundating large regions infused with the very human hope of changing the climate favorably 'down-wind'.

Chapter 25 by Viorel Badescu, Richard B. Cathcart, Marius Paulescu, Paul Gravila and Alexander A. Bolonkin proposes a macro-engineering project which exploits technologies that have the potential to quickly enliven the arid region surrounding Lake Eyre. The plan is focused on biosaline agriculture. The distinctive macro-project components are: Lake Eyre is gradually filled to a higher level by controlling evaporation and by pumping seawater from the nearby Southern Ocean using cheap tensioned textile tubes. Most of the necessary energy to power the pumps and other devices could be produced by photovoltaics, in a very attractive application without electricity storage requirements. Eventually, Lake Eyre is to be lidded with a floating impermeable plastic cap and/or with buoyant hollow plastic balls that reduce evaporation. Filled with seawater, Lake Eyre can be used as a reservoir for irrigation in biosaline agriculture. Elementary mathematical models for the proposed tasks and rough macro-economical estimations are presented. Based on overall results, one concluded that the macro-project is feasible with existing twenty-first century technologies and could become profitable in a few decades time. But beyond paying off the capital investment, the greatest implementation benefit is the prospect of creating beneficial conditions for human settlement in the low-fertility soils of the Lake Eyre Basin. Additional research directions are briefly presented.

Chapter 26, written by Peter Flynn and Jason Songjian Zhou, shows that down-welling ocean currents move carbon into the deep ocean and play a major role in controlling the content level of atmospheric carbon. The formation of North Atlantic Deep Water (NADW) also releases heat to the atmosphere, which is a major contributor to a mild climate in Europe. Modification of down-welling seawater currents by either an increase in carbon concentration or an increase in volume is a possible response to the increase in anthropogenic carbon in our planet's atmosphere and to the possible weakening of the NADW. Seven possible methods of modifying down-welling currents were screened, including using existing industrial techniques for exchange of heat between seawater and the superior air. Increasing carbon gas concentration in down-welling currents is not practical due to the existing high degree of saturation of high latitude surface seawater. Two of the methods for increasing the volume of down-welling seawater currents were found to be impractical, and four were too expensive to warrant further consideration. Formation of thicker annual sea ice by pumping seawater onto the surface of ice sheets is the least expensive of the seven methods for increasing the volume of down-welling currents. One Sverdrup of incremental flow (10^6 m^3 s^{-1}) would have an estimated capital cost of USA$45G and an annual operating and maintenance cost of $1.3G. This macro-engineering method could be employed to avoid a repeat of a mini Ice Age in Europe associated with interruption in the flow of NADW.

Chapter 27 by Roger H. Charlier shows that, broadly-speaking, implementation remains hesitant in the field of harnessing ocean energies. Some research is still in process. Ocean sources of energy can and should be put to work; they are non-polluting, and minimally environment impacting. Their extraction is impeded less by technology than be the onerous capital intensiveness of the necessary investment. Tides, waves, marine winds, have been tapped, other possibilities remain currently more macro-engineers' dreams; they include marine currents, seawater salinity differential, conversion of biological products, marine geothermal energy. Ocean thermal energy conversion is being used in some modest way, but economically it remains unattractive. Before 2010, more than twenty five countries were involved in ocean renewable energy technology development activities. Lack of targeted national priorities and policies remains a major developmental and structural barrier. Offshore marine wind turbines dot today many landscapes, even if environment-related objections are raised (bird kills, weakened air movement down-wind). Wind tapping for electricity generation is still a "young" industry and surrounded by unresolved financial and technical macro-problems. OTEC uses the difference of temperature prevailing between different ocean seawaters layers to produce electrical power. Following the 1973 Oil Crisis, there was a renewed flurry of public interest for OTEC facilities. An OTEC system requires a temperature difference of at least 20–25°C to operate, limiting, in principle, its use to tropical regions. The closed-circuit system is far more ecologically benign than the open-circuit system. Often discussed, ocean currents hold immense potential. However, they have come repeatedly under severe criticism by concerned ecologists and dedicated environmentalists. Harnessing the Gulf Stream near the State of Florida, or placing a barrage within the English Channel, is viewed as unconceivable macro-projects. The ocean currents are driven by wind and solar heating of the seawaters near the Earth's equator, though some ocean currents result from density and salinity variations of water. Harnessing marine currents' energy could be achieved by using submerged water turbines similar to wind turbines that would have rotor blades, a generator for converting the rotational energy into electricity, and a means of transporting the electric current to shore to connect with the nearest electrical grid.

Chapter 28 by Steven Czitrom, Iván Penié Rodríguez and Guadalupe de la Lanza Espino shows that the buffering capacity and low hydrologic dynamics in seacoast water bodies, not necessarily blue-water lagoons, are characteristics that favor a high economic and biological productivity, also rendering them vulnerable to the accumulation of sediments and exogenous substances. The ecological rehabilitation of these bodies of naturally variable salinity water requires decreasing the input of pollutants and increasing the hydrologic dynamics and biodiversity.

With these process objectives in mind, a proposal to install a SIBEO (their Spanish acronym for Wave Energy-Driven Seawater Pump) in each of two nominated coastal lagoons and one seaport in Mexico is made, as the starting point for a national eco-coastal management macro-plan based on the use of renewable energy derived from natural ocean sea-waves. The analyses carried out show that the SIBEO can help diminish the eutrophication process in the coastal zone where it is applied, thus favoring a biodiversity recovery and increased fisheries at relatively low economic costs.

Chapter 29 by Stephen Salter, Joao Cruz, Jorge Lucas and Remy Pascal shows that the electrical energy needed to drive desalination plants can be produced from renewable energy sources if their erratic energy outputs can be made to match the strict specifications of an electrical network (grid). However, energy from sea-waves can also be used directly, using the vapor-compression desalination process. This inherently provides the correct impedance match to seawater wave inputs and does not suffer from wild swings of power outputs. This chapter extends previous work by the authors, by the inclusion of numerical predictions and proposals for a device ocean mooring design.

Chapter 30 by Alexander A. Bolonkin, Shmuel Neumann and Joseph J. Friedlander refers to a unique method for the extraction of freshwater (desalination of seawater) by using solar energy. It entails the following: (1) installation of the desalination system occurs on the sea and, as such, does not require expensive coastal land surface; (2) Desalinization uses solar energy which produces freshwater at a cost close to zero; (3) the device is made from thin film which is far less costly than the conventional reverse osmotic or multi-flash plant materials; (4) ecologically sound, the desalinization device uses sea-waves for water and wetted air circulation; (5) highly transportable, the desalination device may be delivered anywhere by vessels through available shipping sea-lanes; (6) preassembled or disassembled, the desalination device is very compact and easily stored in conventional storehouses; (7) the desalination device also functions as a rain-water collector; (8) environmentally friendly, the desalination system does not dump brine, which is hazardous to some marine life, into the seawater; (9) a portable, inexpensive version of the seawater distiller is available to help travelers produce freshwater when it may be urgently needed.

Chapter 31 by William J. Merrell, Lyssa Graham Reynolds, Andres Cardenas, Joshua R. Gunn and Amie J. Hufton conveys an appreciation of the devastation caused by the 2009 Hurricane Ike and its massive storm surge has forced the Houston/Galveston region to consider means of significantly suppressing storm surge near the Texas shoreline. Due to the significant concentrations of population and the multitude of nationally important industries (such as petroleum refineries) in the region, as well as the difficulties in highway evacuation, attention has focused on the possible construction of a coastal barrier—the Ike Dike—that would help protect the entire Galveston Bay region from hurricane-induced storm surge. Although the devastation caused by Hurricane Ike was the catalyst for action, the realization that other hurricanes could potentially have a much higher surge and the fact that the region is hit by a major hurricane about every 15 years are the factors driving the Ike Dike macro-project concept. The Ike Dike concept envisions a coastal spine composed of the existing Galveston Seawall, extensions of the protection afforded by the Seawall to west Galveston Island and the Bolivar Peninsula and storm surge gates at Bolivar Roads and San Luis Pass.

Chapter 32 by Subba Rao V. Durvasula explains that the Gulf of Khambhat is a high tidal energy environment on the western coast of India and is located in an intensely active seismic zone. The Gulf receives annually 38 km^3 freshwater and 74×10^9 kg of sediment from 12 tributary rivers. The State of Gujarat currently suffers from an acute shortage of freshwater and hydroelectric power, and to alleviate these macro-problems a planned mega-engineering project, 'Kalpasar', is outlined. ["Kalpasar" originates from the Hindu mythological "Kalpa Vriksha" (wishing tree) and means a freshwater lake that "fulfills all human wishes".] The mega-project plan includes damming the Gulf and its tripartite division into a) freshwater reservoir, b) a brackish water tidal basin, and c) the open ocean. A highly stressed environment the Gulf of Khambhat acts as a sink to nutrients from agricultural runoff, and for industrial pollutants and its carrying capacity is in excess of its limit, causing resource conflicts. The proposed tripartite division would have strong environmental impact on the fluvial ecosystem as well as on the inter-basin estuarine and marine ecosystems and may lead to overall deterioration of the Gulf environment. Based on a review of similar mega-engineering projects elsewhere, a comprehensive baseline survey over multi-site, multi-year is recommended to provide a better understanding of the structure, functioning and response and recovery of the Gulf ecosystem to perturbations. A follow up by a thorough evaluation of the impending environmental impacts, similar to those addressed by a Before/After and Control/Impact (BACI model) is emphasized. Other recommendations include construction of several small dams on the various inland rivers to relieve the freshwater shortage, to consider alternative sources of energy, to provide assurance to the public and to develop integrated preparedness systems for management of disasters.

Chapter 33 by Richard B. Cathcart, Alexander A. Bolonkin and Radu D. Rugescu refers to a Bering Strait macro-project. Since great quantities of soil organic carbon previously retained by Arctic permafrost is becoming increasingly unstable because of Arctic Ocean warming, a Bering Strait Seawater Deflector has been devised to stall or even reverse further sea-ice melting. Sea-ice removal by regional climate change, of course, causes the onset and advancement of solar-driven warming of the Arctic Ocean and defrosting of Arctic Ocean Basin permafrost. A sudden and deliberate twenty-first century closure of the Bering Strait is likely to cause an abrupt decrease of the mean temperature of the seawater in the adjacent Arctic Ocean, thus helping to re-establish a greater-than-today sea-ice cover floating on the Arctic Ocean. P. Borisov (1901–1973) was the first to elucidate a costly macro-engineering concept of a concrete dike-like barrier placed within the Bering Strait. Cathcart, Bolonkin and Rugescu, instead, offer a low-cost screen—they call it a textile curtain—separating the Bering Sea from the Arctic Ocean. Their purpose is to significantly reduce the amount of heat in North Pacific Ocean seawater currently entering the Arctic Ocean in order to, ultimately, instigate ground re-freezing of some Arctic Basin permafrost. Successful re-freezing of permafrost would, thus, slow or possibly halt the twenty-first century release of massive quantities of methane locked in that warming soil type because methane in twenty-one times more potent than carbon dioxide gas in warming the Earth-atmosphere.

The principal audience for this book consists of researchers (engineers, physicists, biologists) involved or interested in macro-engineering. The book may become useful for industry developers interested in joining national or international geo-engineering programs. Finally, it may be used for undergraduate, postgraduate and doctoral teaching in faculties of engineering and natural sciences.

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