



Marine and Water Sciences

Steering Committee Report

September 2023

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Preface - Prof. Yoseph A. Mekori, Chair of the Planning and Budgeting Committee of the Council for Higher Education

I am both thrilled and honored to write a few words at the opening of this report. Shortly after I entered office in December 2021, negotiations started concerning the new multi-year plan for Israeli Academia (2023-2028), including a flagship initiative in Sustainability and the Climate Crisis. The road was not an easy one, but once we received approval in principle, we began the process of formation, then nomination, of experts' steering committees in three areas chosen on the basis of existing strengths and growth potential: (1) Energy and Climate, (2) Agriculture, Food/Nutrition and Biodiversity, (3) Marine and Water Sciences.

The report you have in front of you is the result of six months of intensive work that included gathering input from key stakeholders in Academia and beyond, lively discussions, and a process of prioritization and cost/benefit analysis. It contains the recommendations of the Sea and Water Studies Steering Committee, most of which were endorsed by the Planning and Budgeting Committee. Thus, we are now in a position that we have the green light, and a guaranteed budget of nearly 125 million NIS, to put words into action in the coming five years.

This is a timely and most needed investment in research in avenues that were carefully chosen. We have solid grounds to believe that the Israeli scientific community has potential to become a world leader in innovation and development in the field of sustainability, and are happy to be in a position that we can provide a financial boost. The world needs to act quickly in order to brave the daunting challenges ahead. We made sure that Israeli Academia will be able to contribute its share.

I would like to thank the chair and members of the three steering committees for their excellent work and contribution, completely pro bono. My thanks are also extended to the team at the Council for Higher Education, Naomi Beck (PhD), Deputy Director General for Strategy and International Affairs, Gabi Appel, Program Director for Strategy, and Yifaa Yungerman, Program Coordinator for Strategy, for their dedicated work.

The plan is laid, and now we must all endeavor to make it a success even beyond our expectations so that great science will have a great and lasting impact for the better.



Prof. Yossi A. Mekori
Chair, the Planning and Budgeting Committee
The Council for Higher Education

Mission Statement

The impact of global warming is now at our doorstep, already affecting both marine and water sciences. Increased funding is required for basic and applied research in these areas in order to better understand the changes under way, and find solutions for coping with them. As examples for these changes, one can mention toxic algal blooms that because of global warming will intensify in freshwater, coastal waters and marine bodies, necessitating the developments of treatment methods needed to preserve these water bodies as a resource. The melting of polar ice is also a matter of concern, as it endangers the welfare of coastal inhabitants. Biodiversity data (incl. standardized observation protocols and experiments) are needed to monitor long-term spatiotemporal patterns such as the ones mentioned above or ocean acidification, or the progress of invasive species, so that we can better protect and conserve ecosystems. At the same time, blue biotechnology is rapidly developing and promises novel applications ranging from aquaculture to medicine and cosmetics, offering growth opportunities that Israel cannot afford to miss.

Our mission as the Marine and Water Sciences Steering Committee was to provide recommendations for strengthening the Israeli academic community's ability to perform cutting-edge research. The Committee's first aim was to establish a knowledge base and identify bottlenecks. It was immediately noted that, despite the central importance of marine and water sciences to our wellbeing, the scientific community in Israel is relatively small. In addition, the retirement of leading scientists has not been supplanted by the hiring of early-stage researchers. It is thus essential to increase the number of talented Israeli scientists working in these domains, who use interdisciplinary approaches, so that they can become leading figures in academia and in industry.

The Committee also identified several topics where interdisciplinary research centers can promote our understanding of specific sub-fields as well as their practical industrial applications. Such centers should include an outreach component and provide the knowledge-base for stakeholders and policy makers, and, last but not least, help educate the general public.

The Committee members were lauded the allocation of significant funds to the promotion of research in marine and water sciences in Israel. The Committee would like to express its gratitude to the entire community of researchers and experts in the fields of marine and water sciences for their invaluable contribution to the quality of the discussions and to the Committee's recommendations.

Finally, I personally would like to thank the Committee members for serving professionally and passionately, and especially Dr. Naomi Beck and Ms. Gabi Appel for guiding us in this process.



Prof. (Emeritus) Aaron Kaplan, Hebrew University
Chair of the Marine and Water Sciences
Steering Committee

Abstract

The climate crisis and global warming pose serious challenges that require significant investment in understanding and predicting short and long-term processes. Water bodies are key elements in these processes since they are at the same time drivers and subjects of a variety of climatic phenomena such as: rainfall regimes, tropical storms, heat waves, droughts, and more. A significant part of the carbon dioxide emissions due to human activities is absorbed by water bodies, instigating a variety of processes that affect biodiversity such as photosynthesis which increases the availability of food in water, or acidification, which, together with the increase in water temperature, causes considerable mortality of sensitive organisms (e.g., corals) and has other, wide-ranging implications. Global warming is also intensifying the crisis of drinking water in large areas around the world (and with it the need to use reclaimed water), causing, for instance, a significant increase in the distribution of populations of algae and toxic photosynthetic bacteria in lakes and beaches, making them unusable for human purposes.

Clearly, water bodies should constitute a major research focus with regard to sustainability and the climate crisis, unfortunately the marine and water sciences' academic community in Israel has suffered from insufficient support for many years. In order to promote the quality, scope and research capabilities of this community, the Planning and Budgeting Committee of the Council for Higher Education decided to appoint an advisory committee of experts. The committee was asked to map, characterize and prioritize the research needs in marine and water sciences in Israel, and recommend a five-year plan of action that would help leverage specific areas in which Israeli scientists have potential to significantly contribute to the promotion of both basic and applied research.

The Steering Committee based its discussions on two recent reports, one prepared by the Israeli Academy for the Sciences and the Humanities, and one by an international evaluation committee (see details below), as well as on reviews and position papers prepared by the Steering Committee members, on data collected from surveys sent to higher education and research institutions in Israel, and on more than 40 conversations held with researchers and experts in relevant sub-fields.

The recommendations of the Steering Committee are outlined in this report. Below is a short summary:

1. Human capital - about 30% of the budget – mostly for infrastructure and research start-up grants for new faculty members, but also for doctoral and postdoctoral fellowships. The Committee recommended encouraging collaborations between universities and governmental research centers such as [Israel Oceanographic and Limnological Research \(IOLR\)](#) in the hiring of new faculty in order to make optimal use of existing infrastructures for both research and teaching purposes. The Committee also recommended examining the possibility of tuition and living scholarships for first degree students in water engineering in light of the acute shortage in the field.

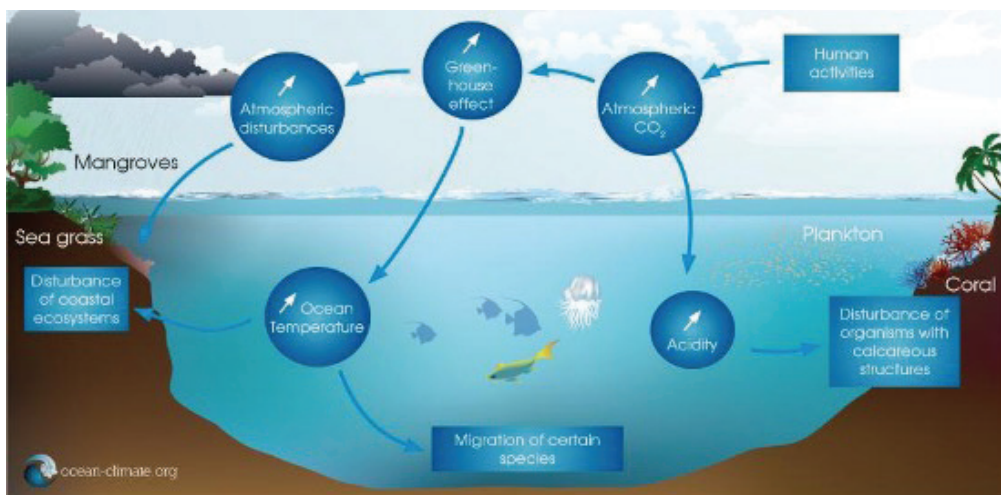
2. Research and teaching infrastructures at an inter-university Institute for the marine science at the Red Sea (approx. 25% of the budget).
3. Assistance in financing navigations and the use of equipment for marine research (approx. 14% of the budget) in order to reduce research expenses and increase the potential for winning competitive research grants.
4. Research centers (approx. 30% of the budget):
 - a. Marine Research Centers that will focus on the study of changes in chemo-physical and biological parameters in the Mediterranean Sea in time and space in response to changing environmental conditions, as well as on the processes driving marine biodiversity changes.
 - b. Limnological Research Center for that will focus on the study of terrestrial water systems such as lakes, reservoirs, and streams.
 - c. Water Quality Research Centers that will focus on the study and treatment of anthropogenic pollutants (e.g., hormones, antibiotics and microplastics), and on the development of new systems for desalination, methods for water recycling, and physical models for simulation of hydrological processes. The Committee is of the opinion that cooperation with a water treatment facility, such as the [Dan Region Wastewater Institute](#), will be able to advance research in the areas above, and lead to better use of existing and planned research infrastructure.

The Committee would like to express its gratitude to the entire community of researchers and experts in the fields of marine and water sciences for their invaluable contribution to the quality of the discussions and to the Committee's recommendations.

Background

Marine and water sciences have become a focal point in international discussions on climate crisis R&D strategy and investment in recent years. For example, since 2015 they are a central element in UN [SDGs](#), in particular goal number 6 "Clean Water and Sanitation," and goal number 14 "Life Below Water." In 2017, the UN launched the "[Ocean Decade Alliance](#)" for 2021-2030. The importance attributed to marine and water research is also manifest in the significant budget allocated for their promotion in the European R&D Framework Program for the years 2021-2027, Horizon Europe ([approx. 100M euros in 2023-2024 alone](#)).

A significant part of the carbon dioxide emissions due to human activities is absorbed by water bodies, instigating a variety of processes that affect biodiversity such as photosynthesis which increases the availability of food in water, or acidification, which, together with the increase in water temperature, causes considerable mortality of sensitive organisms (e.g., corals) and has other, wide-ranging implications. Global warming is also intensifying the crisis of drinking water in large areas around the world (and with it the need to use reclaimed water), causing, for instance, a significant increase in the distribution of populations of algae and toxic photosynthetic bacteria in lakes and beaches, making them unusable for human purposes.



Source: [IUCN, 2017](#)

In Israel, the status of marine science has been the object of the work of various committees and reports in recent years: Report of the International Committee for the Evaluation of the Quality of Research Centers in the Field of Marine Science (2018); Report of the International Committee for the Evaluation of the Quality of Marine Science Studies (2018); Climate Technology Innovation Report (2021); Report of the Israeli Academy of Sciences and Humanities' Committee for the Assessment of Marine Sciences in Israel (2021), chaired by Prof. Zvi Ben Avraham. The latter report offers an in-depth analysis of the state research in the field of marine science in Israel and around the world,

including background materials and summaries of previous reports, and maps out the strengths and knowledge gaps in marine research in Israel. It also presents a detailed proposal for an academic program to promote marine science, including the required budget. Since there have been very little changes in the state of the field in Israel since the publication of said report, we did not find it necessary to redo the analyses.

Marine Research in Israel: Challenges and Responses

In the report of the committee appointed by the Israeli Academy of Sciences and Humanities, and chaired by Prof. Ben Avraham, the field of marine science was defined as having significant potential for advancing the economy and resilience of the State of Israel. However, despite the discovery of natural gas in Israel's territorial waters, which has tremendous importance for Israeli economy, and despite subsequent major operations for its extraction, the necessary steps have not been taken to promote marine science, even though its promotion is clearly necessary in order to realize the full economic potential, and to acquire data for the purpose of evaluating the impact of the above actions on the environment and the climate. Although the sea is a strategic national resource, Israel has not defined itself as a "sea state," and has scarce resources and infrastructure for marine science. This albeit a growing demand for resources directly or indirectly related to the sea such as: food, water, energy, natural materials, and an increasing interest on the part of various stakeholders who make use of the marine environment.

Ben Avraham's report highlighted the lack of trained personnel in academia and industry, and of infrastructure necessary for the development of marine science. According to the report, there is insufficient local investment in securing food sources, biological diversity, and marine natural treasures, and in preventing environmental disasters, and a better preparation to marine pollution incidents. It was also noted that marine research is characterized by multi-disciplinarity, and the use of complex and expensive research infrastructures. The main infrastructures in the field, such as research ships and ROVs, are currently concentrated in the Interuniversity Institute for Marine Sciences in Eilat (IUI), in the [Israel Oceanographic and Limnological Research Center \(IOLR\)](#), which is a State-owned enterprise, and in the Mediterranean Sea Research Center of Israel (MERC). Most of the research in recent decades has been done in shallow waters due to the lack of infrastructure for deep sea research.

In view of the above, the committee, chaired by Prof. Zvi Ben Avraham, recommended to establish a national program that would provide solutions for the growing need for marine research, and advance the field in Israel, thus placing it on the same footing as neighboring and more distant countries, whose investment in marine research and the study of marine resources are constantly growing. The proposed academic program included the following components:

1. Expanding and strengthening the scientific and engineering community engaged in basic and applied academic research in marine science by recruiting new faculty members, collaborating with faculty members from other fields, and increasing the number of graduate students and post-doctoral fellows.

2. Expanding training in marine science and making it accessible to students from non-related technological fields, as well as from the social sciences and the humanities. The training will include tracks for technical personnel.
3. Providing the research infrastructure required for positioning the State of Israel as a leader in the field of marine science, in a way that allows use by researchers from all institutions of higher education and by the industry, and providing the financial resources required to conduct competitive and innovative breakthrough research.
4. Developing academia-industry-government interfaces, e.g., sharing infrastructure, joint research centers, research collaborations, knowledge and tech transfer, and encouraging external investments in academic research, both for the economic development of Israel as well as for creating opportunities for the academic community.

It should be noted that gaps identified in the report mentioned above were already highlighted in a previous report from 2018 written by the International Committee for the Evaluation of the Quality of Research Centers in the Field of Marine Science, chaired by Prof. Colin Brownlee from Southampton University, England, and former Director of the Marine Biological Association. The report was written at the request of the Planning and Budgeting Committee of the Council for Higher Education as following its decision to examine, among others, the Interuniversity Institute for Marine Sciences in Eilat (IUI) and the Mediterranean Sea Research Center of Israel (MERC I). The committee found that the location and unique approach of the Interuniversity institute in Eilat to the promotion of inter-institutional marine research led to a steady stream of publications of excellent quality, including numerous contributions to the development of the field. Thus, the Interuniversity Institute became an international center of excellence for marine research, especially in the field of marine biology and ecology. The report also noted that the Interuniversity Institute has the potential to become a world leader in coral reefs studies, ocean-reef interactions and the biogeochemistry of nutrient-poor water bodies. At the same time, the committee remarked that the Interuniversity Institute's goals, which are ambitious but achievable, were not developed as part of a national strategy for marine sciences. In other words, the institute's potential can be realized only if the required investments are made.

Challenges in the Field of Water Studies in Israel

The study of "terrestrial" water, Limnology (Inland Waters), is the scientific research of diverse water systems: lakes, reservoirs, rivers, streams, swamps, green basins and groundwater - as ecosystems that interact with their drainage basins and the atmosphere. Limnological research includes the biology, geology, physics, chemistry and climatology of these water systems, and focuses on understanding the interrelationships between the system's components and the ways to preserve their function as ecosystem service providers. The main system services are the supply of water for the needs of humans and their environment while using this resource sustainably. Due to the increased utilization of terrestrial water systems, and their proximity to and dependence on diverse pollution factors, research and development in the field of engineering is required to manage these systems and to ensure sustainable use of water as a resource. Water and wastewater treatment, desalination of seawater and brackish water, identification and control of pollution sources are only

some of the areas of knowledge where research is required to achieve this goal.

Israel's geographical location on the desert border greatly influenced the history of this country. In ancient times, this had implications for settlement stability. Recently, the settlement of the Jewish people in Israel about a century and a half ago was accompanied by the development of water sources, without which it would not have been possible. Development of water sources, and water supply plants has grown over the years. An extensive network of water drillings was deployed, regional water plants were established, and the highlight was the establishment of the National Water Carrier, which transported water from the water sources in the north to the Negev Desert in the south, but it also raised the need for an in-depth limnological study of the water source: The Sea of Galilee (Kinneret). Without the various developments related to water supply, for both drinking and industrial purposes, and especially for agriculture, it would not have been possible to sustain the mass immigration that arrived after the declaration of the State of Israel.

When the population grew, and natural water sources were exhausted, Israel was required to switch to industrial water production through desalination of Mediterranean water. In addition to creating a new source of drinking water, Israel has begun to reclaim treated wastewater for agricultural irrigation. Today the situation is such that in approx. two years' time, Israel will have close to 900 million cubic meters of water from seawater desalination, and another 600 million cubic meters of wastewater for agricultural reclamation, in addition to an average amount of 1.2 billion cubic meters of water from natural sources (this amount varies according to climatic conditions, so during long dry cycles, it can be reduced to 700 million cubic meters).

Along with population growth and increased density, extensive industrial development, full utilization of natural water sources, and large-scale wastewater irrigation, arose complex environmental problems stemming directly from issues related to the exploitation of Israel's water resources: untreated, or undertreated sewage water were made to flow into streams, causing loss of natural habitats; Toxic industrial factories released hazardous wastewater into the ground without treatment and severely contaminated water sources, shutting down water drillings; leaks from sewage systems caused sewage water to penetrate underground and contaminate groundwater underneath urban spaces; overuse of aquifers caused drying up of springs, which then led to decreased steam flow and lowered water levels, thus intensifying the danger of sea water penetration into the aquifer and of an increase in water salinity to the point of disqualifying aquifers as a source of drinking and irrigation; coastal desalination plants detract land from coastal areas, and this will only intensify in the future as the population grows, and with it the demand for water; the expansion of cities and settlements has brought the urban space closer to water drillings, that in the past were located further away, thus resulting in an increases risk of pollution from human sources. The ecological pressure on The Sea of Galilee, as a result of agricultural and urban activity up and around the lake, have affected its ecological balance, which is manifest in the alteration of phytoplankton populations and the invasion of cyanobacteria algae that replaced the dominant algae in the lake. This fundamental change reflects and demonstrates a decline in water quality in the lake and its ecosystem, compared to several decades ago.

As of today, the forecast for rising sea levels has devastating implications for Israel's beaches, near which most of Israel's population is concentrated. In terms of the water sector, the real risk is the penetration of seawater into the coastal aquifer, and also into parts of the mountain aquifer. Another consequence of global warming is a change in rainfall regimes. The climate forecast is that the amount of precipitation in the region will decrease by about 20% and the significant change will probably occur in the second half of the century. **Therefore, basic and applied research, as well as long-term planning, should focus on ensuring the reliability of water supply in an appropriate quantity and quality for all uses, while rehabilitating and preserving aquatic systems, the Sea of Galilee and streams** (see Appendix A). This challenge is not unique to Israel since many parts of the world where severe water crises are developing, both as a result of climate change and as a result of population growth, face similar problems.

The knowledge gaps that need to be addressed are in a wide range of areas (see Annex B) that can be grouped together under two main categories: (1) inland water and (2) hydrology, hydrogeology and water quality. Research is required into various aspects of the above: identifying and monitoring trends and phenomena, developing advanced monitoring approaches while integrating innovative technologies, developing and using technologies and tools for data analysis, identifying problems, developing models for predicting phenomena, examining measurement methodologies, and more. In addition, there are other engineering research and development issues that require attention, such as: methods for advanced sewage treatment solutions (removal of additional pollutants in accordance with updated standards), identification and management of pollution sources, better coverage of water reservoirs with solar panels, introducing roof run off into the subsoil to reduce the extent and frequency of flooding in urban spaces, and more.

Another point to note is the lack of skilled personnel in the field. The development of the water sector in Israel over the past 100 years has been based on skilled engineers, which enjoyed the respect of their peers for their important service. In order to maintain Israel's position as a world leader in water production and treatment, scientific and engineering excellence must be further developed. Today, however, we are experiencing a drastic decline in the quantity and quality of professional manpower in this sector. There is a clear and urgent need to strengthen the academic research systems that contribute to the education and training of the next generation of water engineers.

The issue of the quantity and quality of professional manpower in various sectors has led the government to establish an inter-governmental taskforce: "Infrastructure 2030". The taskforce pointed to gaps in the professional level of personnel recruited to the public service in the field of engineering, and to the need to formulate a plan to reduce these gaps in the short and long terms. Among other things, the taskforce recommended investing in human capital related to water infrastructures, and in particular increasing the number of civil engineers, students and faculty members in the field.

In order to bridge the gaps and provide a response to the various needs, it is necessary to combine different actions and systems. Alongside the promotion of human capital, research centers should be established, databases should be created for the collection and analysis of data from academic and monitoring systems, and advanced measurement means should be deployed in diverse environments.

Composition and Mode of Work of the Steering Committee

The Steering Committee was assembled starting with the appointment of the chair, Prof. (Emeritus) Aaron Kaplan from the Hebrew University, who has expertise relevant to marine and water sciences and biology. Then, following consultation with Naomi Beck (PhD), Deputy Director General for Strategy and International Affairs at the Council for Higher Education, several scientists were approached, aiming for a balance of expertise in the different areas under the Committee's responsibility, and considering gender balance and representation of the different academic institutions in Israel. A representative of the Planning and Budgeting Committee of the Council for Higher Education, Prof. Shiri Navon Venezia (Ariel University) was also nominated to the Committee. The selection of Committee members was also done while avoiding potential conflicts of interest. Below is a table of the Committee's composition, divided into two sub-panels according to expertise (+) in Marine and Water Sciences.

Composition of the Energy and Climate Steering Committee

Table 1: Composition of the Marine and Water Sciences Steering Committee	Marine Sciences	Water Sciences
Prof. (Emeritus) Aaron Kaplan (Hebrew University) (Chair)	+ + Open Sea subcommittee	+
Prof. Yigal Erel (Hebrew University)	+	+
Prof. Yishai Weinstein (Bar-Ilan University)	+ Open Sea Subcommittee	
Prof. Yaron Toledo (Tel-Aviv University)	+ Open Sea Subcommittee	
Prof. Yitzhak Makovsky (Haifa University)	+ Open Sea Subcommittee	
Prof. Shiri Navon-Venezia (Ariel University, Member of the Planning and Budgeting Committee)		
Dr. Assaf Sukenik (Israel Oceanographic and Limnological Research Center)		+
Prof. Orit Sivan (Ben-Gurion University)	+	+
Prof. Ilan Koren (Weizmann Institute)	+	+
Prof. Uri Shavit (Technion- Israel Institute of Technology)	+	+
Giora Shaham (Israel Water Authority, Retired)		+

The Committee met a number of times: January 9, 2023 – first meeting, 1.2.2023 – second meeting, 20.3.2023 – third meeting, 16.5.2023 – fourth meeting (online) and 29.5.2023 – fifth meeting (online). In addition, Committee members discussed and met with representatives from a broad number of bodies, including: [Israel Oceanographic and Limnological Research \(IOLR\)](#), the [Israeli Association for Marine and Water Sciences](#), [Dan Region Wastewater Institute](#), and consulted with nearly 40 researchers from Israel and around the world, including representatives from Kinneret Limnological Laboratory, and universities presidents and rectors. In May, a meeting took place with the heads of the two other sustainability steering committees (Energy and Climate; Agriculture, Food/Nutrition and Biodiversity) to explore overlaps and joint interests.

During the opening meeting, the Committee Chair noted that previous committees of the Israeli Academy of Sciences and the Humanities and of the Quality Evaluation Department at the Council for Higher Education, mentioned above, have recently drafted comprehensive reports concerning the research needs in marine science, which can be of considerable assistance to the Steering Committee's work and shorten the process of coming up with recommendations, unless the Committee members believe that some of the recommendations should be reviewed. There was consensus that these background materials can be relied upon.

Despite the body of knowledge that existed, it was agreed that to prevent inaccurate analysis due to lack of information in specific domains, a survey should be conducted that would help validate the needs of the various academic institutions in the fields of marine and water sciences. The Committee adopted a survey format formulated by the chair of the Agriculture, Food/Nutrition and Biodiversity Steering Committee, with the necessary adjustments (see details below). The survey was sent to the presidents of the research universities as well as Kinneret College and Ruppin Academic Center. The purpose of the survey was to determine the size and quality of the scientific community in certain fields, to validate its current needs and desires against the situation known among the Committee members, and against previous reports, as well as to assess the potential of institutions to lead in specific areas. At the same time, the survey also aimed at getting as broad as possible information from experts in the Israeli community concerning their views on the nature of challenges and possible solutions. In addition, the Committee discussed additional proposals raised by sub-committees on the specific topics of open sea research and terrestrial waters (lakes, streams, etc.).

The Survey

The survey consisted of 10 questions for each sub-field:

Questions 1 to 6 aimed at understanding the Institutions' needs and competencies

1. List up to 5 topics in each category, that you define as foci of excellence in your institution in sustainability research.
2. List names of up to 10 scientists from your institution, in each category, who are experts in these fields (you may include both established and young PIs).
Please provide separately the top 10 recent publications for each scientist (incl. links to articles when possible).
3. List 2 Infrastructures you consider necessary to promote excellence in sustainability research in your institution in each category.
4. List up to 3 tools (other than infrastructure) you think would enable to promote excellence in sustainability research, e.g., Research Grants, Hiring new PIs, Fellowships, Teaching, Other.
5. Name 2 centers of excellence that you wish to establish in your institution in each topic.
6. Other comments/suggestions

Questions 7 to 10 aimed at getting experts' feedback.

7. What are the greatest sustainability-related challenges that we are likely to face in the coming decades in each category?
8. What are the greatest foreseeable opportunities for advances in sustainability science in each category?
9. What fundamental knowledge gaps exist that limit the ability of scientists to respond to these challenges as well as take advantage of the opportunities?
10. What general areas of research should be advanced and supported to fill these knowledge gaps?

Recommendations of the Steering Committee

The Committee's discussions focused on advancing marine research in the Mediterranean Sea and the Gulf of Aqaba on the one hand, and research on freshwater in water basins, streams, lakes and reservoirs, including research related to water quality and pollutants, wastewater, reclaimed water, and hydrological models, on the other. The Committee's chair and members proactively approached various experts and researchers who expressed their opinions in writing, among others: Prof. Avital Gazit and Prof. Yossi Levy from Tel Aviv University, Prof. Alex Furman from the Israel Institute of Technology (Technion), Prof. Noam Weisbrod from Ben-Gurion University, Prof. Hezi Gildor from the Hebrew University, Prof. Ilana Berman-Frank and Prof. Daniel Sher from Haifa University, and many other researchers (more than 40) with whom the Committee members held individual discussions.

The Committee would like to express its gratitude to the entire community of researchers and experts in the fields of marine and water sciences for their invaluable contribution to the quality of the discussions and to the Committee's recommendations.

On the basis of all the materials gathered, the Committee members defined the main topics for further discussion, and contacted colleagues in relevant fields who assisted in the preparation of additional specific position papers on topics such as: (1) the needs for research in the open Mediterranean; (2) hydrological simulation models: various options for simulation of hydrological and other processes related to fresh water; (3) water sciences and the water economy in Israel: gaps and needs for the advancement of research and training. Finally, the Committee conducted discussions with representatives of water treatment facilities to explore the possibility of collaborations with Academia.

Regarding the study of the Mediterranean Sea, the Committee members adopted the recommendations of prior reports mentioned above, and concluded that without significant investment in research infrastructures in the Mediterranean Sea such as (but not limited to): measurement equipment for a variety of biotic and abiotic conditions over time, maintenance of existing research equipment, and a significant increase in technical personnel, it will not be possible for marine research to be carried out at the required level.

In addition, the Committee recommended taking further action with the Ministry of Finance with respect to the law pertaining to the [Israel Citizens' Fund \(2014\)](#), in particular section 38(d)(2), which refers to the proposal the Israeli government is required to make, including annual budget allocation, "for advancing research and development, as well as investment in renewable energy and the development and research thereof." The Committee believes some of the profits levied on gas and oil receipts should be used to finance the long-term development of marine science research in Israel, as is done in other countries (e.g., Denmark). In addition, the Committee recommended developing academia-industry-government interfaces, e.g., sharing infrastructure, joint research centers, research collaborations, knowledge and tech transfer, and encouraging external investments in academic research, both for the economic development of Israel as well as

for creating opportunities for the academic community.

Regarding the Inter-University Institute in Eilat (IUI), there was consensus among the Committee members that its level of excellence in both scientific and administrative aspects (as also stated in the external reports noted above), merits expansion of its research activity, including the absorption of additional scientists and investment in infrastructure for research and teaching (the IUI is the main teaching center for students in advanced degrees in the field). It should be noted that in Government Decision 1442 (2022), 10 million NIS were allocated on behalf of the Ministry for the Development of the Negev and the Galilee for the promotion of academic research and teaching in Eilat pending matching funding from the Planning and Budgeting Committee.

With regard to fresh and reclaimed water, here too there was consensus in the Committee, supported by submitted position papers, concerning the need to promote research in these areas, in which Israel is a world leader. Committee members held a number of discussions and meetings to examine cooperation between academia and water treatment facilities, notably with representatives from that [Dan Region Wastewater Institute](#), which serves the Tel-Aviv metropole area, and is the largest in Israel, and one of the most sophisticated in the world. The possibility of conducting collaborative research between the institute and one or more academic institutions, on topics of mutual interests such as: the examination of new models for water desalination, hydrological simulation models for subsoil flow (and more), bacteriological challenges (water treatment facilities are incubators where microorganisms need to cope with drug residues, hormones, viruses, etc.), and the effect of reclaimed water use on agricultural crops and the microbiome near the roots was examined. The Committee members believe that the proposed collaboration will contribute to both basic and applied research in Israel in numerous aspects, including medical and agricultural. Therefore, it is necessary to enlist the relevant government ministries to promote research on these issues.

During the Committee's discussions the idea of creating a scholarship program for doctoral students was raised, which was also mentioned in some of the previous reports and in replies to the survey. However, as discussions proceeded, it became clear that there is sufficient support for outstanding doctoral students at universities, and therefore it was decided to recommend funding a postdoctoral fellowship program that would assist outstanding PhDs to pursue training at leading institutions abroad in preparation for a career in Academia later on. This, along with start-up grants for new faculty (both research and equipment), were voted the best avenues for promoting the fields of marine and water sciences, other than the research centers mentioned above.

Finally, the Committee members also highlighted the acute shortage of water engineers and the need to greatly increase the training of high-level professional personnel in the field. The Committee recommended the establishment of a scholarship program for outstanding undergraduate students in the field for a total amount of 3.44 million NIS for five years, which was to covers tuition costs of outstanding 3rd and 4th year students plus a living scholarship of 30,000 NIS for those two years (8 scholarships per year, 40 in five years). This recommendation is, however, not included in the list of recommendations below because such a program cannot be executed within the framework of the current flagship. The Committee therefore recommended that the Planning and Budgeting Committee contact the relevant ministries and authorities (e.g., the Ministry of Energy. The Water

Authority) to explain the need described above, and find a way to implement the proposed solution.

The Committee's recommendations for a five-year plan to advance the field of marine and water sciences are listed below.

1. Marine Research Centers

(20M NIS for 2-4 research centers, maximum 10M NIS per proposal)

The strategic importance of the Mediterranean Sea to Israel is salient in many aspects, including: national security, economy, transportation of products, energy, impact on climate, and quality of life. Despite this, there are serious knowledge gaps concerning various geochemical and physical parameters, and their expected response to changing environmental conditions in space and time. Below are two (non-limiting) examples for marine research centers that may help reduce these gaps.

- **A Mediterranean Observatory:** The Committee recommended supporting a center dedicated to the long-term study of the Mediterranean Sea with a focus on changes in the marine environment in time and space. The center will be able to coordinate research on a variety of variables, mainly chemo-physical and biological, of the water and air column above it, from data collected using an array of measuring devices: sensors anchored in stationary positions adjacent to the seafloor, measurements and samples taken during navigation excursions and/or by robotic means and remote sensing, and analyzed using AI tools and other advanced methodologies.
- **Studying Processes Leading to Change in Marine Biodiversity:** We are experiencing significant changes in biodiversity in the surrounding water bodies, which are attributed to climate change, but the mechanisms that drive these changes, especially those relating to intra-population communication, are unclear and mostly unknown. A center dedicated to this topic will help reduce knowledge gaps in the field.

2. Water Quality, Reclaimed Water and Hydrological Processes - Research Centers

(15M NIS for 3-4 research centers, maximum 6M NIS per proposal)

Population growth in Israel, utilization of natural water sources, and changes in rainfall regimes and quantity (especially those predicted to occur due to climate change), require desalination strategies, and the use of treated wastewater for agricultural irrigation. Since Israel is a world's leader in water production and treatment, it is only natural that many questions/problems arise here, which require basic research (with local and global practical implications) in order to advance our understanding, and maintain Israel's lead in this field, on a variety of topics such as:

- a. Identification and treatment of water pollutants, some of which come from human sources (e.g., as antibiotics, hormones and microplastics);

- b. New methods for water desalination (e.g., developing new membranes), and for the reduction of energy-use in this process;
- c. Physical models that enable simulation of hydrogeological processes for a better understanding of water infiltration, mixing processes of various types of water, etc;
- d. New models for wastewater treatment;
- e. Microbiological processes during water treatment.

It is important to clarify that water treatment facilities are incubators for basic microbial processes with wide-ranging medical and epidemiological implications such as the creation of bacterial strains resistant to antibiotics, identification of viruses and disease centers, and more. The Committee recommended supporting research centers that will study the variety of topics presented here, and others, in cooperation with one or more of the wastewater treatment facilities in order to make optimal use of the infrastructure capabilities found there, including conducting hydrological research on water in various treatment stages, and using laboratory equipment for the preparation of research samples.

The Committee was aware of the fact that the budget proposed was much lower than the needs in this important area, and proposed that in parallel to the basic research that will be carried out within the framework of the five-year plan, and aside of the collaborations with wastewater treatment facilities, an attempt will be made to secure additional budget for the promotion of research in the field, inter alia, from government ministries such as Energy, Agriculture, Health, and Environmental Protection.

3. Terrestrial Water Systems (Limnology) – Research Centers

(5M NIS for one research center)

The study of “Inland Waters”, or limnology, is the scientific research of diverse waters systems: lakes, reservoirs, rivers, streams, swamps, green basins and groundwater - as ecosystems that interact with their drainage basins and the atmosphere. Limnological research includes the biology, geology, physics, chemistry and climatology of these water systems, and focuses on understanding the interrelationships between the system’s components, and the ways to preserve their function as ecosystem service providers.

In Israel, the limnology of terrestrial water systems refers to the study of: The Sea of Galilee (Kinneret), several hundred reclaimed water reservoirs used for irrigation, and streams, most of which are active only in winter. Population growth and the resulting reduction of open spaces are factors that lead to a reduction in water sources to water bodies in Israel, in addition to the expected decrease in the amount of rainfall due to global warming. Furthermore, due to the increased utilization of terrestrial water systems, and their proximity and susceptibility to various pollutants, it is of great importance to promote research relating to the man-

agement of these systems in order to ensure the sustainable use of water as a resource.

Israel is world leader in terms of water production as a result of prolonged research and development activity that was carried out to meet the urgent needs of the developing country, and was promoted scientifically and technologically in universities and research institutes. The further development of scientific excellence and engineering capabilities in water science will ensure Israel's leading position as water crises intensify (quality and quantity) in Israel, and in many regions around the world. The Committee recommended providing support for a research center that will promote limnology of diverse water systems in order to track, analyze, understand and predict processes and changing trends in these systems, as well as their rehabilitation.

4. Upgrade of the Teaching and Research Infrastructures of the Inter-University Institute in Eilat

(30M NIS + 10M NIS matching funding from the Ministry of the Negev and the Galilee)

The Red Sea and the Gulf of Aqaba have strategic importance for Israel, both in terms of relations with bordering countries, and in economic terms (tourism). In the context of the Sustainability and Climate Crisis Flagship Initiative, it is important to emphasize the uniqueness of the Gulf of Aqaba, which has specific geo-chemo-physical and biological characteristics that can help understand the impact of climate change on our environment. At the chemo-physical level, the regime of currents from the Red Sea to the north (due to the evaporation of water in the northern part of the bay), and the resulting salinity changes, cause the water to settle close to the city of Eilat, creating a flow cycle that causes higher water temperature at greater depths than in other seas, which remains constant throughout the year. This enabled the development of the Gulf's unique coral reef in a relatively northern region, where there are no similar coral reefs. The location of the reef has made it a sensitive barometer/sensor for climate changes, hence its unique importance with respect to sustainability and climate crisis research. An important logistical advantage that greatly reduces the expenses of marine research in Eilat lies in the fact that the coral reef and the deep sea are within minutes' sailing distance from the coast (because of the Great Syrian-African rift), thus researchers from around the world are keen to come to Eilat.

Currently, an Inter-University Institute for marine research and teaching operates in Eilat, as a partnership between seven of Israel's public research universities. Under the auspices of this Institute unique inter-institutional collaborations take place, which receive praise and recognition from many sources (committees of the Israeli Academy for Sciences and Humanities, teams of international researchers, marine researchers and students). Research at the Institute in Eilat is carried out by nine resident scientists, and close to seventy resident students and postdocs who carry out their research work there. About 40% of the students are international, and come from the world's leading universities. They are joined by about sixty Israeli scientists from local research institutions and their students, who come for short and concentrated research periods.

In addition to teaching resident graduate students, the institute conducts a series of marine science courses open to all universities in Israel. In total, about 500 students study at the institute each year. The courses provided by the institute, through which the future generation of researchers in the field is trained, are in great demand: on average, four students compete for each open spot.

In light of the above, the Committee recommended investing 30 million NIS in infrastructure to promote research and teaching activities at the Inter-University Institute in Eilat, and another 10 million NIS matching from the Ministry of the Negev and the Galilee, as per Government Decision 1442 (2022).

5. Navigation and Marine Research Equipment Fund

(18M NIS)

The Committee recommended establishing a competitive fund for financing navigation excursions and the use of marine research equipment (e.g., ROVs) that are required for conducting cutting-edge research in the field. Today, the lack of a separate funding source is a significant barrier to the advancement of groundbreaking research in the field, since the very high cost of navigation excursions puts a heavy burden on the budget allocated via existing research grants, thus reducing substantially the grant's total amount. In many places around the world, including the US and Europe, it is customary therefore to provide funding for navigation excursions and the use of marine research equipment via external sources (to the grant).

The Committee recommended establishing a competitive fund following a division into two funding tracks:

- Additional equipment grants for awardees of personal research grants (PRGs) of the Israel Science Foundation (ISF) (up to 10 million NIS over 5 cycles)
- Grants that will be distributed competitively, with an emphasis on pooling resources for optimal utilization of navigation excursions and marine research equipment, through a mechanism that will be approved by the Planning and Budgeting Committee (up to 8 million NIS over five cycles).

6. Human capital: Start-Up Grants for New Faculty and Postdoctoral Fellowships (36.750 million NIS)

It is necessary to invest in human capital and support the recruitment of faculty members in order to strengthen the academic community engaged in marine and water sciences, and expand the fields of research to those in which innovative tools are required. Thus, the Committee recommended the establishment of start-up grants for new faculty members as detailed below:

Experimentalists: 1.25 million NIS grant for laboratory equipment + 170,000 NIS start-up research grant.

Theoreticians: 250,000 NIS recruitment grant + 50,000 NIS start-up research grant.

In addition, in order to boost the new generation of researchers in the field, the Committee recommended the establishment of a postdoctoral fellowship program for outstanding graduates as follows: \$120,000 for a 2-year fellowship in a leading institution abroad X 3 fellowships per cycle (= a total of 15 postdoctoral fellowships over the 5 years of the initiative).

Budget (in Million NIS) for a Five-Year Plan (2024-2028)

Marine and Water Sciences		
Research Centers *	Marine Research (2-4 centers, maximum per offer: 10M NIS)	20
	Water Quality/Hydrological Processes (3-4 centers, maximum per proposal: 6M NIS)	15
	Terrestrial Water Systems (one center)	5
Inter-University Institute for Marine Research in the Red Sea	Infrastructure for research and teaching	30
Navigation & Marine Research Equipment Fund	Supplements to ISF's Personal Research Grants	10
	Supplements to non-ISF Competitive Grants	8
Human Capital	Start-Up Grants for New Faculty (research & equipment)	30
	Postdoctoral Fellowships	6.75
Total		124.75