



SUSTAINABILITY IN COASTAL AND OCEANIC ECOSYSTEMS: A CLUSTER OF EXCELLENCE IN THE EXTREME SOUTH OF BRAZIL

Executive Summary

Institutional Plan-Institutional Proposal for Internacionalization

Federal University of Rio Grande - FURG

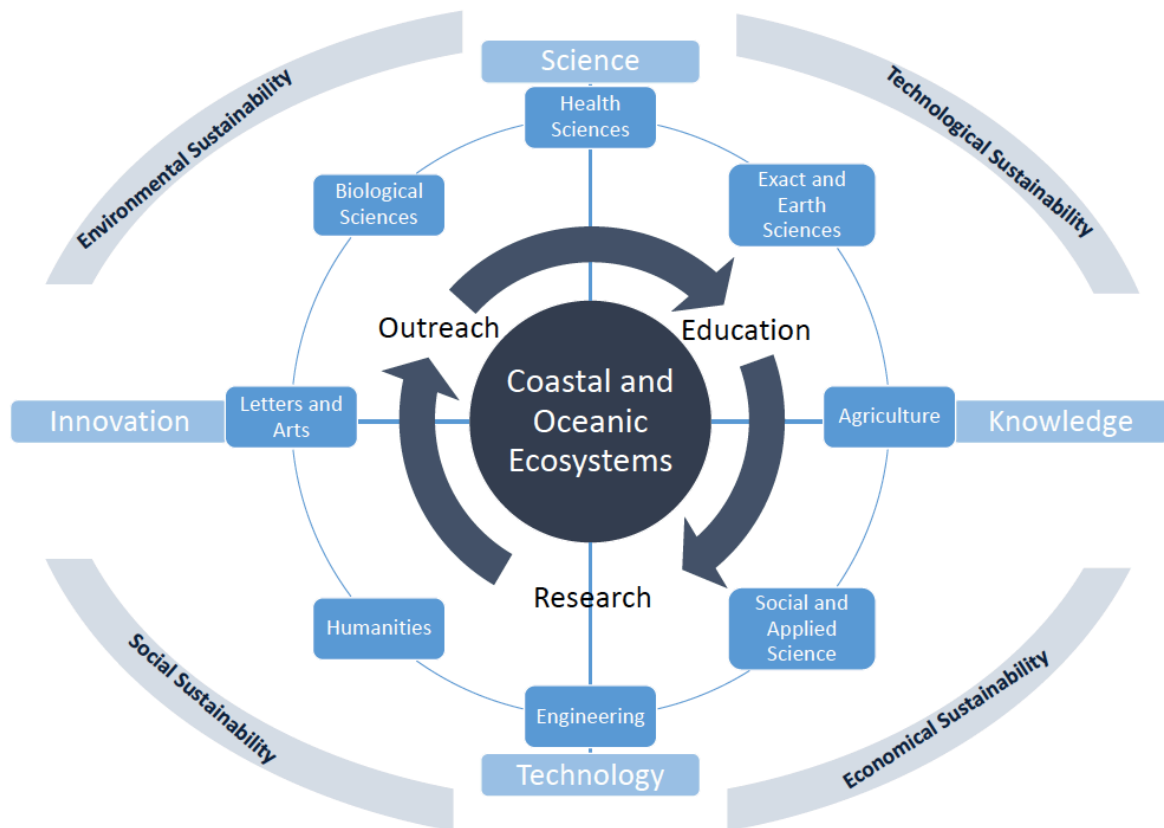
In the contemporary world there are a growing number of themes of global scope, affecting the planet in its entirety. Examples of such themes include global climate change, the search for peace between and within countries, the demographic explosion, efforts to reduce poverty, and the various aspects of the search for a global sustainable development. All these themes have a general understanding that they need to be considered and studied in a comprehensive and integrated way. In other words, they are themes that need a systemic or holistic approach. In addition, the vast majority - or almost all - of these global issues have a strong connection to oceans and coasts. A sample of this connection can be exemplified in some of the aforementioned themes. The theme of Global Climate Change for example has a strong relationship with the dominant rise in the average level of the oceans, generating global security problems in coastal areas, with serious threats related to erosion and flooding. The search for international peace is similarly related to the military use of the oceans, historically considered fundamental for geopolitical issues or for the establishment of areas of control, influence and domination among nations. In the sense of the search for poverty reduction, the oceans may have or play an important role in the food security aspects when one considers their enormous contribution to the supply of protein from fisheries and aquaculture. Likewise, national or regional poverty conditions can be alleviated by adequate access of countries to their energy resources such as oil and gas, as well as renewable resources such as from winds, waves and tidal sources. Finally, when considered globally, the "sustainable development" theme is necessarily related to the sustainable use of the oceans and coasts, represented for example by protocols of responsible fishing, rational use of its energy and mineral resources and establishment of international governance of the oceans.

There are some important assumptions when we consider the coverage of the oceans and coasts and the related themes. First, it is important to consider the fact that

oceanic and coastal systems do not recognize political boundaries. In fact, the oceans physically integrate municipalities, states, countries or global regions. Therefore, in order for us to develop the study and monitoring of the current associated global issues, predominantly, with the oceans and coasts, it is imperative to have international cooperation in its various dimensions. It is in this thematic context and within this scope of internationalization for a necessary global cooperation that the Federal University of Rio Grande-FURG developed and presents its institutional academic proposal to the CAPES PRINT Program.

The Federal University of Rio Grande - FURG expresses itself as an integrated, conceived, structured and developed academic system, having as reference its vision, mission, official policy and specific complementary policies, based on guiding principles. The institutional strategic objective of the Federal University of Rio Grande (FURG) is to promote a complete education, emphasizing a general education that contemplates technique and the humanities, that is capable of enhancing creativity and critical thinking, fostering the sciences, arts and providing the knowledge necessary for human development and for community life. Thus, it is FURG's mission to serve with high quality, guided by ethical and democratic principles, so that the result of its educational action has an impact on the community and contributes to the improvement of the quality of life of individuals and to regional development. *Coastal and Oceanic Ecosystems* are the strategic areas of action of FURG, which seek to produce, organize and disseminate knowledge about the processes, complexities, dynamics and sustainability of these environments through teaching, research and outreach. In this context, FURG considers that its increasing inclusion in a globalized contemporary context, through processes of internationalization, is fundamental for the achievement of its objectives and its mission.

In a synthetic way, the following schematic diagram represents the approach adopted by FURG's official philosophy.



In the figure it is possible to observe the focus of FURG on marine and coastal ecosystems, as a scope that involves teaching, research and outreach activities of the university. In this focus, it is important to highlight the integration of all areas of knowledge in their aspects related to knowledge, science, technology and innovation. All these areas of knowledge manifest peculiar characteristics by composing, being or expressing the components and processes of marine and coastal ecosystems. Furthermore, in its official policy, FURG adopts a strong emphasis on the search for sustainability in several aspects related to the areas of knowledge. These are environmental sustainability, technological sustainability, economic sustainability and social sustainability.

Briefly, FURG defines itself as a university focused on coastal and ocean ecosystems, socially and environmentally committed and aligned with local, regional, national and global sustainable development in all areas of knowledge. In this sense, two of the main objectives of the FURG's Institutional Development Plan (PDI-FURG) are clearly related to the international scope: (1) To consolidate itself as a national and international reference in teaching, research and outreach in its area of action and (2) To develop and consolidate university internationalization policies.

Recently, FURG institutionally qualified itself with the development and implementation of an internationalization policy and plan. Both were strongly stimulated by (1) FURG's official philosophy, mission and vision, focused on oceanic and coastal ecosystems, (2) contemporary global themes related to oceans and

coasts, and (3) by an objective perception of the need for its empowerment, and as an enabler element in the participation of opportunities such as that presented by the CAPES-PRINT program.

The Internationalization Policy of FURG is drafted as a brief document highlighting the principles upon which it is based and relatively fixed institutional objectives. The principles observed by the policy involve *cooperation* (collaborative actions guided by shared objectives and interests), *reciprocity* (relations of mutual collaboration and shared solidarity that value equity in the proposed actions), *transparency* (a procedure for full shared access to information and actions on internationalization), *curricular flexibility* (expansion of possibilities and formative spaces in a dynamic academic structure), and *excellence* (academic quality of reference in the fields of teaching, research, production and popularization of knowledge, culture and innovation).

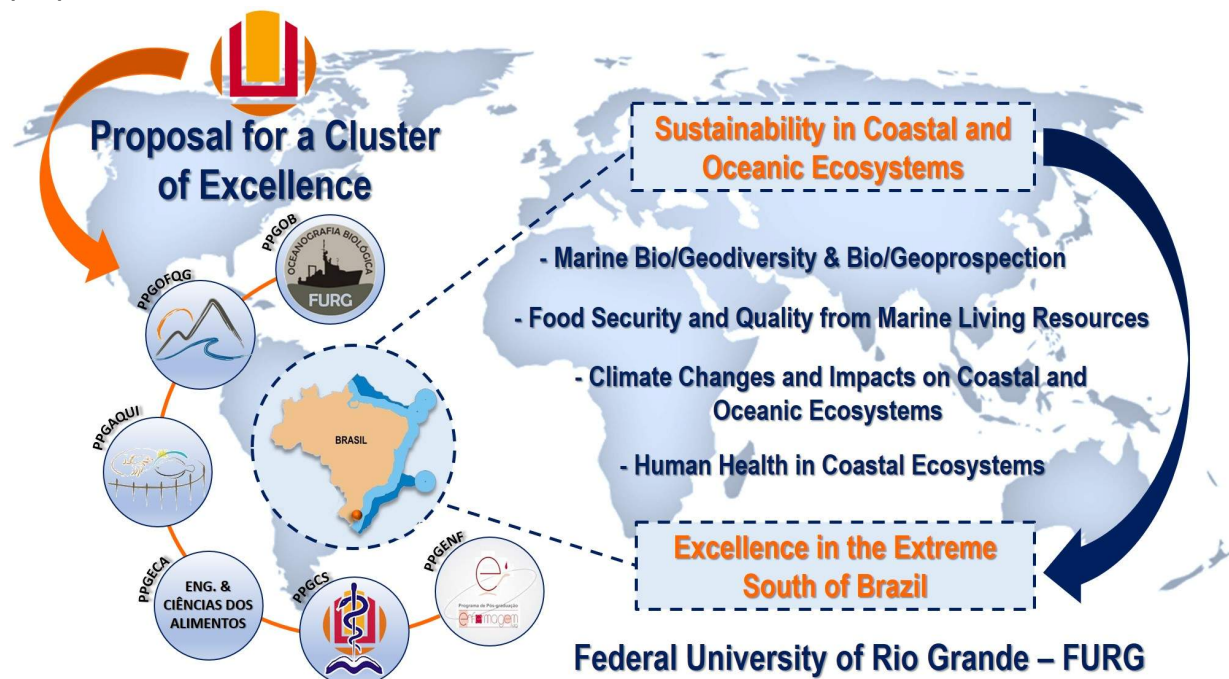
On March 23, 2018, the University Council - the highest-level body in the university administration formally approved the internationalization policy. The document, in its entirety, can be accessed at <http://www.conselhos.furg.br/delibera/consun/00418.pdf>. In the policy, the following institutional objectives for internationalization were approved: (1) *to establish guidelines for the elaboration of Strategic Internationalization Plans*; (2) *to strengthen the insertion and international visibility of FURG*; (3) *to expand opportunities for undergraduate and postgraduate studies at foreign institutions*; (4) *to encourage training opportunities under a cotutelle scheme with double degrees abroad*; (5) *intensify FURG's interactions with the government and society at large, with the aim of increasing the promotion of internationalization actions*; (6) *to increase the number of students, technicians, researchers and foreign professors to FURG at undergraduate and graduate courses*; (7) *expand FURG's participation in publications in periodicals, books and international events*.

Continuing with the approval of its internationalization policy, FURG prepared and established a strategic plan for internationalization actions, aimed at the implementation of the policy. The Internationalization Plan (IP-FURG) was drafted as a substantially detailed document, with reference to policy objectives. In the IP-FURG, the actions are nested in strategic axes that correspond to the objectives of the Internationalization Policy. They are conceived in the form of modules that include their rationality; expected results; goals; indicators; persons responsible for implementation, coordination and monitoring; sources of funding. The Internationalization Plan of FURG was formally recognized and approved by its Board of Education, Research, Outreach and Administration on April 6, 2018. It is structured in the form of 43 strategic internationalization actions and can be accessed at <http://www.conselhos.furg.br/delibera/coepea/02218.pdf>.

FURG's proposal to CAPES PRINT Program, entitled "Sustainability in Coastal and Oceanic Ecosystems: A Cluster of Excellence in the Extreme South of Brazil", has multiple characteristics that robustly connect it to the university's official philosophy, its

processes and instruments of internationalization and finally to the outstanding contemporary global themes. It is conceived in the sense of installing and implementing a cluster of excellence consisting of Graduate programs with strong relation with the aforementioned characteristics and committed to the advancement of knowledge and human resource training through internationalization processes.

The following figure represents the design of the cluster of excellence contained in the proposal.



The cluster is designed for the integration of Graduate programs in (1) Biological Oceanography, (2) Physical, Chemical and Geological Oceanography, (3) Aquaculture, (4) Engineering and Food Sciences, (5) Health Sciences and (6) Nursing. This integration is delineated through a joint and interactive effort for the development of four projects, taken here as strategic axes in the search for excellence of the programs involved through multiple internationalization processes. In addition, they are key themes in the global issues of the oceans and coasts. The thematic axes of the cluster are:

- I. *Bio/Geodiversity and Marine Bio/Geoprospection*
- II. *Food Security and Quality of Marine Living Resources*
- III. *Climate Change and Impacts on Coastal and Oceanic Ecosystems*
- IV. *Human Health in Coastal Ecosystems*

The *Bio/Geodiversity and Marine Bio/Geoprospection* project integrates the training of researchers and the development of research that addresses the identification, mapping, prospecting, monitoring of biological and geological richness and diversity of the oceans and their coastal zones with a special but not exclusive focus, in the South

Atlantic. The prospection of the geological diversity seeks the identification and mapping of minerals of economic interest including oil, gas and metallic nodules. Many of these marine mineral resources are still largely unexplored and, in many cases, unknown. At the same time, these resources are sources of energy and matter that supply a significant part of the current world economic matrix and, potentially, can become protagonists of a new, more just and sustainable future matrix. The oceans harbor the greatest biodiversity on the planet. The deep knowledge about this immense biological diversity and its relation with the environment is of fundamental relevance to identify Ecologically and Biologically Significant Areas (EBSAs) and to subsidize conservation strategies that aim at the long-term viability of these species and their ecosystems. Ecosystems with greater diversity are, as a rule, more resilient to natural and anthropic impacts. In addition, marine species, besides providing food, have broad biotechnological potential. Thus, one way of extracting economic value from marine biodiversity is bioprospecting, which can be defined as the systematic search for organisms, genes, enzymes, compounds, processes and/or parts from marine life that may lead to product development. Bioprospecting is relevant to a wide range of sectors and activities, including biotechnology, agriculture, nutrition, the pharmaceutical and cosmetics industry, bioremediation, health, among others. In this area, the world pharmaceutical sector depends to a large extent on bioprospecting: more than half of the existing drugs have been developed from biological molecules, many of them from the sea. All this will contribute to food security and health in the future.

The *Food Security and Quality of Marine Living Resources* project investigates the potential of marine living resources from fisheries and aquaculture as a sustainable source of high quality food for the growing human populations. It is known that food security is linked to ensuring everyone's right of access to quality food in sufficient quantity on a permanent basis, based on healthy eating practices and without compromising access to other essential needs or the food system future, and should be carried out on a sustainable basis. In this sense, Brazil must be sovereign to ensure its food security, respecting the cultural characteristics of each region, manifested in food habits, specifically from quality marine resources, from obtaining the raw material to the excellence of the final product. The project also addresses the sustainable use of these resources by assessing their state of exploration and exploration of alternatives to fish stock management measures and the development of responsible aquaculture (with minimal water renewal). In addition, the project investigates the potential for aggregation of nutritional value to marine products (food science and technology) and low risk to human health (through the analysis of chemical and biological contaminants).

The *Climate Change and Impacts on Marine and Coastal Ecosystems* project aims to assess the effects of climate change on oceanographic dynamics and its consequences on coastal and ocean ecosystems, including variation or loss of biodiversity, changes in population dynamics and areas of distribution of fish stocks

and possible damage to coastal structures, as well as changes in biogeochemistry and contributions of leachate contaminants from the continents, atmosphere or even remobilized from the melting of permafrost areas. It is projected that in the coming decades, due to global warming, among other factors, there will be an increase in the frequency of occurrence of El Niño events of great intensity, among other extreme events. These extreme events can, for example, impact the biological production of the oceans, such as low krill biomass around Antarctica, affecting all trophic networks in the Southern Ocean that depend on this key species. Higher rainfall combined with a decrease in the polar cryosphere will result in flooding, an increase in freshwater discharge and sediment, and sea level rise. These processes directly interfere with the leaching, remobilization and contribution rates of natural compounds, nutrients and chemical contaminants, causing damage to agriculture, health and public safety in coastal regions. The increasing concentration of carbon dioxide in the atmosphere, when absorbed by the oceans, causes its acidification, compromising the viability of species that depend on carbonates for the formation of their rigid structures. As a consequence, there will be changes or losses of biodiversity, which affect the resilience, functioning and potential of ecosystem services, including those that provide food security, such as fisheries. In addition to these environmental damages, the increase in average atmospheric and oceanic temperatures could trigger the emergence or expansion of tropical diseases in subtropical regions, as well as raise levels of chemical contaminants in the atmosphere as a consequence of increased volatilization and impacts on public health.

Finally, the *Human Health in Coastal Ecosystems* project also seeks to prospect and evaluate the biotechnological potential of marine resources in the production of pharmaceutical inputs and new drugs of national interest, and to investigate the trends and forms of control of epidemics and endemics typical of port and/or related to social fragility, such as AIDS and other sexually transmitted diseases, hepatitis and tuberculosis. Studies of the genetic diversity of infectious agents make it possible to identify the entry into the country of exogenous strains belonging to port regions, as well as to monitor the eventual clonal dispersion of more virulent and antibiotic resistant strains. The development of these researches is also aimed at minimizing human vulnerability related to climate change and the sustainability of socio-environmental health through the development of nursing, health, education, ethics and work studies and technologies, articulated to populations living in different coastal ecosystems responsible for the changes on their health profile. With global warming, an increase in rainfall intensity, sea level rise, and possible effects on the living condition and expansion of the area of coverage of tropical diseases to subtropical regions are projected. Therefore, the formation of highly trained human resources is crucial for greater efficiency in the diagnosis, prevention and control of diseases and illnesses that affect human health and quality of life in coastal ecosystems. In an integrated way, with other objectives, prospection seeks to identify the potential, in the immense marine biological diversity, of the production of new drugs and of species

capable of providing food of high nutritional quality to help in the fight against diseases and to improve the general health condition of the needy population.

FURG's proposal, through the four strategic projects, seeks to achieve the desired level of consistency in different areas. First, to be consistent among shared objectives through the proposed cluster components. In the same way, the proposal sought to be consistent with FURG's internationalization policy and plan, and ultimately established consistency with global issues affecting oceans and coasts.

The objectives of the four strategic axes are set out as follows:

(1) Train human resources and develop research to identify, map, quantify and monitor the bio and geodiversity of the oceans and their coastal zones, with a special focus on the South Atlantic.

(2) Train human resources and investigate the potential of marine living resources from fisheries and aquaculture as a sustainable source of high quality food for the growing human population.

(3) Train human resources and conduct research to assess the effects of global climate change on oceans and their consequences for ecosystems and society.

(4) Train human resources, diagnose and prospect ways of preventing and controlling diseases and illnesses that affect human health and quality of life in coastal ecosystems.

Therefore, the consistency between the proposed objectives and the cluster structure, conceived by the graduate programs with areas of action that enable them to carry out shared actions in pursuit of the achievement of these objectives, is therefore noteworthy.

In order to meet the established objectives, the proposal foresees actions to be carried out by the cluster with a clear internationalization character. In addition to being consistent among the components of the cluster, the internationalization actions demonstrate a relation and compliance with the strategic axes proposed in the Internationalization Plan of FURG (IP-FURG).

The first set of actions involves the development of projects and training of graduate students abroad in the areas of marine bio and geodiversity, food safety and quality, climate change and its impacts on ecosystems and human health, and quality of life in coastal ecosystems. This set of actions clearly addresses Strategic Axis 3 of the IP-FURG, which proposes "*To increase the participation of FURG students and staff in undergraduate and graduate courses, as well as in different academic and administrative actions in foreign institutions*". The institutional academic quality gain is undeniable for universities capable of providing international exchange experiences for their students, professors, researchers and administrative staff. The expansion of the participation of FURG students and staff in academic and administrative activities

in foreign institutions involves a series of detailed actions in IP-FURG. These include the expansion and consolidation of undergraduate and graduate mobility programs, the training of students and staff for mobility, and the prospection and expansion of international agreements to support participation.

The next set of actions of the proposal foresees the training of faculty abroad in the areas of marine biodiversity and geodiversity, food safety and quality, climate change and its impacts on ecosystems and human health and quality of life in coastal ecosystems. Like the previous set of actions, it meets Strategic Axis No. 3 of the IP-FURG.

The following set of actions foresees the attraction of international visiting professors for the development of teaching and research activities in the areas of marine biodiversity and geodiversity, food safety and quality, climate change and its impacts on ecosystems and human health, and the quality of life in the coastal ecosystems. This set of proposed actions directly meets that established in Strategic Axis No. 4 of the IP-FURG, which proposes "*To foster the participation of foreign students, researchers and professors in undergraduate and graduate courses at FURG, as well as in different academic and administrative actions*". This strategic axis of the Internationalization Plan involves multiple actions related to mobility, but, in a prominent way, should establish the necessary conditions at FURG for the processes of attraction, possible settling and good efficacy of the participation of students, researchers and foreign professors to the courses of undergraduate and graduate degrees at FURG, as well as in different academic and administrative actions.

The proposal then presents a set of actions that involves the accomplishment of overseas work missions for the execution of projects related to the areas of marine biodiversity and geodiversity, food safety and quality, climate change and its impacts on ecosystems and human health and quality of life in coastal ecosystems. Here, in addition to meeting what Strategic Axis No. 3 (above) proposes, this set of actions is directly related to Strategic Axis 2 of the IP-FURG, which proposes "*Strengthening the insertion and international visibility of FURG*". Currently, FURG has 72 international agreements with institutions from Europe, the Americas, Oceania, Asia and Africa. The strategic objective are (1) to expand agreements, primarily in countries and continents with which FURG does not yet have agreements and which are an international benchmark in the areas of performance of similar graduate programs; and (2) to consolidate and strengthen existing agreements through the development of cooperation projects, doctorate in *cotutelle* schemes and double degrees, attracting international visiting professors and conducting postdoctoral studies.

The next set of actions proposes the attraction of young talented researchers, with experience abroad, for the development of teaching and research activities. This is similar to the conclusive set of actions that foresees the attraction of researchers with experience abroad to carry out postdoctoral activities in the areas of marine

biodiversity and geodiversity, food safety and quality, climate change and its impacts on ecosystems and health and quality of life in coastal ecosystems. Both sets of actions relate to and comply with IP-FURG Strategic Axis No. 4, which proposes “To foster the participation of foreign students, researchers and professors in FURG undergraduate and graduate courses, as well as in different academic and administrative actions “

Finally, it is noted that the integration of the set of actions developed by the cluster certainly provides fundamental elements for the achievement of the Strategic Axis 7 of the IP-FURG, which foresees "*Increasing FURG's participation in publications in periodicals, books and international events and international research consortia*". The expansion of FURG's participation in publications in international journals, books, events and consortia of research can be taken as an integrated indicator of the university's capacity for internationalization, with emphasis on its research groups and graduate courses. In the case of graduate programs, the international insertion of scientific production and, ultimately, of the graduate programs themselves is a crucial factor for CAPES' systematic evaluations. In particular, courses of level six and seven only reach such a condition of excellence from the establishment of an advanced level of international production and insertion. In addition, IP-FURG deals with training activities aimed at international scientific production, which include the provision of foreign language courses and translation and proofreading services for scientific production in a foreign language.

The proposal to create a center of excellence focused on the sustainability of oceanic and coastal ecosystems in the extreme south of Brazil is consistent with several structuring elements for internationalization at FURG. Initially, there is an alignment and a lead of the proposal sharing the philosophy, vision and mission of FURG, focused on oceanic and coastal ecosystems. The proposal supports the most comprehensive aspects of university philosophy, represented by the expressions of environmental, technological, economic and social sustainability.

Likewise, the proposal integrates and promotes much of the implementation of substantial aspects of the FURG Internationalization Plan. The combined actions to be developed in the cluster context are strongly related to the Strategic Axes numbers two, three, four and seven. In this sense, the cluster in action would become a fundamental element for the implementation and development of the university's Internationalization Plan.

Finally, it is important to highlight the consistency of the theme and of the proposed projects as guiding lines of the cluster with outstanding global contemporary themes. The knowledge of marine bio and geodiversity and its necessary prospecting (first project) are fundamental for the definition of the current state of the oceans and coasts. The oceans cover more than 70% of the Earth's surface and are fundamental to life on the planet. In addition to influencing and regulating the climate, its vast

marine and coastal ecosystems harbor a vast, still unknown, biodiversity and geodiversity that is not fully mapped and quantified. Mineral resources, in turn, are sources of energy and matter to supply part of the world economic matrix. The dynamics of the oceans and their size have the potential to produce, among other services, clean energy, by means of currents, waves and tides, to add to the energy grid and provide important foreign exchange for the country. Despite this relevance, coastal and, especially, oceanic ecosystems are the least studied on the planet.

Global climate change and its potential impacts on coastal and ocean ecosystems (third project) are key issues for the environmental sustainability and economic sustainability of the planet. In addition to human actions that sometimes generate direct negative pressures in marine and coastal environments, the impact of climate change, which includes, for example, trends in increasing the surface temperature of the planet and the concentration of carbon dioxide in the atmosphere, have the potential to aggravate such pressures. In this sense, the synergistic effects of direct anthropogenic-derived degradation and impacts from climate change threaten the health of the oceans, endangering the resilience of their ecosystems and the security of human populations.

Issues related to food security and quality from marine resources (second project) and human health in coastal ecosystems (fourth project) are strongly related to the issues of global social sustainability. The biological diversity of the oceans represents quality food security through fisheries and aquaculture and its biotechnological potential, an immense space for discoveries of new pharmaceutical inputs. Likewise, maintaining food security and population health through sustainable use of the oceans will be considered by the cluster as a major element in the quest for human well-being and poverty reduction.

In a conclusive way, FURG's proposal to the CAPES-PRINT program seeks to be conceived and interpreted as the insertion of a cluster of excellence on oceanic and coastal sustainability into a virtuous cycle. (1) Part of global ocean issues, (2) Work on strategic issues through a process of personal and institutional empowerment through internationalization initiatives ("at home" and elsewhere) and (3) Generate human and institutional capacities capable of acting on the original themes and the search of global oceanic and coastal sustainability. The concern for the sustainable use of the oceans has grown at a global level. The United Nations recently declared the oceans an objective target in Goal 14 (Sustainable Development Goal - SDG 14) in its Sustainable Development Agenda 2030. Such an importance of oceans for climate life security on Earth has also led the United Nations to declare 2020-2030 as the Decade of Oceanographic Studies. FURG's proposal to the CAPES-PRINT Program seeks to become a concrete contribution of the Federal University of Rio Grande-FURG to this decade and to this great challenge.