

UFSC Micro Basin—A Preliminary Study: A Stream to Call It Ours



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Abstract The object of this study was the micro basin of *Campus* UFSC, component of the surface slope and drainage network of Itacorubi Hydrographic Basin (HB) in Florianópolis city (Brazil). The HB is the unit of planning and environmental management preferred, but the establishment of a sub unit as the *Campus* UFSC micro basin can be exemplary. The objective of this exploratory research conducted between April and July 2011, was to characterize and locate the water

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drainage network contributors of micro basin of the *Campus*, select the main and associate them with environmental indicators. 72 source points of water contributions to the formation of the *Campus* UFSC micro basin were identified, photographed, georeferenced, mapped and organoleptically characterized. Surrounding critical areas in the public health sphere—as well as socio-cultural and landscape patrimony, quality of specific ecosystems and local economy—were identified. This study proposed environmental indicators in order to guide a plan for conducting water quality diagnosis and identification of factors that negatively impact the aquatic ecosystem of UFSC *Campus*. The construction of environmental and sustainability indicators for the study of environmental conditions in this area is necessary and urgent, because it is a tool of great importance for driving programs working towards the recovery and revitalization of the Itacorubi HB and in the monitoring of its development.

Keywords Micro basin UFSC · Higher education and sustainability
Environmental indicators · Water pollution · Hydrographic basin

1 Introduction: Hydrographic Basin as a Space for Environmental Studies

In Brazil, income inequality and social exclusion are factors that drive flows of migratory population movements from rural areas or small urban centers towards large cities and, more recently, from large cities to small and the medium-sized ones, which offer better employment opportunities (Braga 2006). In addition, the lack (or inexistence) of an environmental public policy as a support for urban territorial management and planning has led to the expansion of new urban centers in an environmentally and socially inefficient way (Nascimento and Vianna 2009; Mireya et al. 2014).

Merely technical solutions have not been enough to promote sustainable development of urban areas in Brazil. Based on this fact, the concept of sustainable development would not be enough to overcome the ecologically unsustainable rational economic model, although being born of an environmental crisis generated by an economically inefficient, environmentally damaging, and socially perverse productive process. In order to add theoretical consistency to the understanding of socio-environmental sustainability, it is necessary to deepen the understanding relevant connections between natural, social and exact sciences with politics and economy.

Universities are important references for society, whereas they are preserved as important centers of knowledge. These institutions produce solution to the problems experienced by society, as an opportunity to improve life quality, as well as a place

of people education. In that sense, universities realizations and how they are performed will act as a parameter for many sectors of society (Sorentino et al. 2011).

However, as discussed by several authors (Leff 2001; Tauchen and Brandli 2006; Albareda et al. 2017; Braßler and Block 2017), within the framework of the university system, there is a set of difficulties to the formation and work of interdisciplinary teams. This issue ranges from the holistic approach—necessary for social and environmental sustainability—to the lack of a knowledge capable of expressing the complexity of interactions between natural and social systems.

Limited and partial nature of disciplinary knowledge, by not grasping the connections between social and natural aspects, has restricted itself to internalizing ecological and technological norms, sometimes disregarding a social conflict analysis, as well as the political dimension that permeates environmental field (Leff 2001). In these difficult circumstances, acting in an interdisciplinary way does not mean a secured path to the formation of a group with a different disciplinary knowledge, but only the construction of a process that focuses on the object of study in an interdisciplinary way. In this sense, connections are established between the direct object of an action and problem generation/overcoming forces.

It is always a great challenge to find the best way to express environmental degradations caused by human intervention. This issue is due to the different levels of degradation, which range from a milder disturbance to situations when ecosystem is completely destroyed.

The establishment of a Hydrographic Basin (HB) as a territorial unit of environmental planning and management was a technical attempt to overcome the understanding that anthropic actions would be restricted to the point of intervention, as well as its positive or negative impacts. In the words of Yassuda (1993), the hydrographic basin is the unitary stage of interaction between water and physical, biotic, social, economic and cultural environments. This fact allows an assumption that it is not possible to treat the environment dissociated from anthropogenic actions and from the interdependence between natural ecosystems and civilizational development.

Itacorubi HB has registered one of the highest urban HB expansion rates in Florianópolis. UFSC, as well as other public and private institutions, have been the main motivators of this expansion in the region (Florianópolis 1994; Santos 2003; Collares et al. 2004). This basin is included in part of the sewerage network of Florianópolis since 2003, but it has not been enough to assure water quality. Despite the high number of important and large-scale institutions located within Itacorubi's HB, the protection of its waters from contamination caused by sewage generated from economic activities and residences is not avoided (Laurenti 1993; Bueno 2000; Cristo 2002; Florianópolis 2009).

Although the delimitation of an ecoregion is facilitated by a territorial definition of a BH, ecological features observed at smaller scales—such as in micro or sub-basins—may also provide management subunits to solve localized environmental problems (Calijuri and Bubel 2006). Therefore, this project delimited UFSC *Campus* micro basin as the territorial base for the environmental unit to be studied. Moreover, this restriction is also justified by limitations of the project itself, that is,

to be carried out in only 4 months, without any financial aid and exclusively by voluntary students and the research professor.

Environmental indicators and descriptors are widely used to estimate the conditions of natural and social ecosystems. In this way, these tools can assess impacts, formulating, planning and implementing environmental (preventive or curative) policies and strategies. Later, it is possible to evaluate the performance of proposed policies and actions (IBGE 2002; OECD 2003).

Descriptors are generic and qualitative characteristics of the system that represent and guarantee their stability. The indicators collaborate in the investigation of the characteristics that will give significance to the chosen descriptors, providing simple and synthetic information on the environmental condition of the studied environment. Since there is no set of global indicators adaptable to any reality, it is necessary to evaluate and analyze the context (social, economic, cultural) where environmental systems are inserted. It happens because they describe specific processes, for which they are applied in a particular way.

Depending on the theoretical model adopted, environmental indicators are constructed within restrictive or broad concepts. Conceptual models have evolved from the most simplistic ones, like PSR (Pressures, State, Response) (OECD 1993), to more complex ones, like DPSIR (Driving forces, Pressures, State, Impact, Response) (PNUMA-CIAT 1996; Smeets and Weterings 1999).

DPSIR model allows usage of several categories of indicators: (a) direct or indirect causes associated with environmental state (pressures linked to human activities); (b) environmental quality (natural environment condition or state); (c) impacts of anthropic activities on the environment (negative or positive effects); (d) actions (responses and remedial, prospective and alternative policies). In this way, the DPSIR model can perform an integrated environmental assessment, considering both the human activity sectors that generate driving forces and pressure elements that generate impacts on the state of the environment (living conditions of human populations, ecosystems, and natural reserves), which require responses of different types and levels.

Although this study has carried out activities in the field for the environmental and social data collection in the region, they are not discussed in this article. This article will address only the opportunity of proposition of environmental indicators obtained from socio-environmental observations, like developers and advisors for a planning stage of the diagnostic study of socio-environmental ecosystems.

A debate about the genesis of inefficiency of public policies on urban spatial planning and its influence on social and environmental quality goes far beyond the intention and capacity of the study.

The motivation to carry out the project approached by this paper was born out of the desire to contribute to life quality and citizenship of marginalized and impoverished populations around UFSC micro basin. Additionally, it is also intentional to contribute to the construction of an institutional environmental policy for UFSC.

In fact, two important initiatives, between 2012 and 2014 and still in progress, promoted by the UFSC Central Administration were strongly inspired by this

research, in the environmental area, covering the UFSC *Campus* micro basin and neighborhoods surrounding the Institution.

One of them was the signing of a Protocol of Intent between UFSC and the Municipality of Florianópolis, where the University conditioned the transfer of part of its territory to the region's road expansion, only if the Municipality and Catarinense Water and Sanitation Company (CASAN) would expand the current sanitation network to all districts adjacent to the *Campus*, due to problems of streams contamination by sewage coming from surrounding urban agglomerations. The other initiative was the financing of an institutional development project entitled "Recovery Project of Water Quality on Streams of Reitor João Davi Ferreira Lima Campus".

2 UFSC Micro Basin

UFSC university community is represented by 40,000 people, including students, technical and administrative staff, teachers, and outsourced service staff. The surrounding region concentrates various economic activities of the tertiary sector (commercial and services) and houses federal, state and municipal government agencies. UFSC *Campus* micro basin (Fig. 1) is a component part of Itacorubi drainage basin, which has a total area of 26.582 km².

The drainage micro basin receives contribution of streams originated in a few hills surrounding the *Campus*, which also cross several residential neighborhoods (Pantanal, Trindade, Córrego Grande, Carvoeira and Serrinha) with a great heterogeneous social formation. The main stream, called Rio do Meio, runs about 4.0 km and crosses the *Campus* in a south-north direction, being recharged by the tributaries Serrinha, Pantanal, Cesar Seara, Eletrosul, and Carvoeira, which mouth is Itacorubi Mangrove.

The micro basin is located between the geographic coordinates 27°35'–27°36' S latitude and 48°30'48°31' W longitude, with an area of 6.023 km², and hydrographic network of 17.413 km (LABDREN 1997a, b). Other of the basin characteristics are in Table 1.

3 Research Methods—Field Activities

This study was based on exploratory and descriptive research, involving bibliographic consultation and field observations. The field research, with predominantly qualitative characteristics, occurred between 04/2011 and 07/2011. Field activities involved:

- (a) **identification, description, photographic registry and georeferencing of water contributions components of the UFSC *Campus* micro basin:** 72

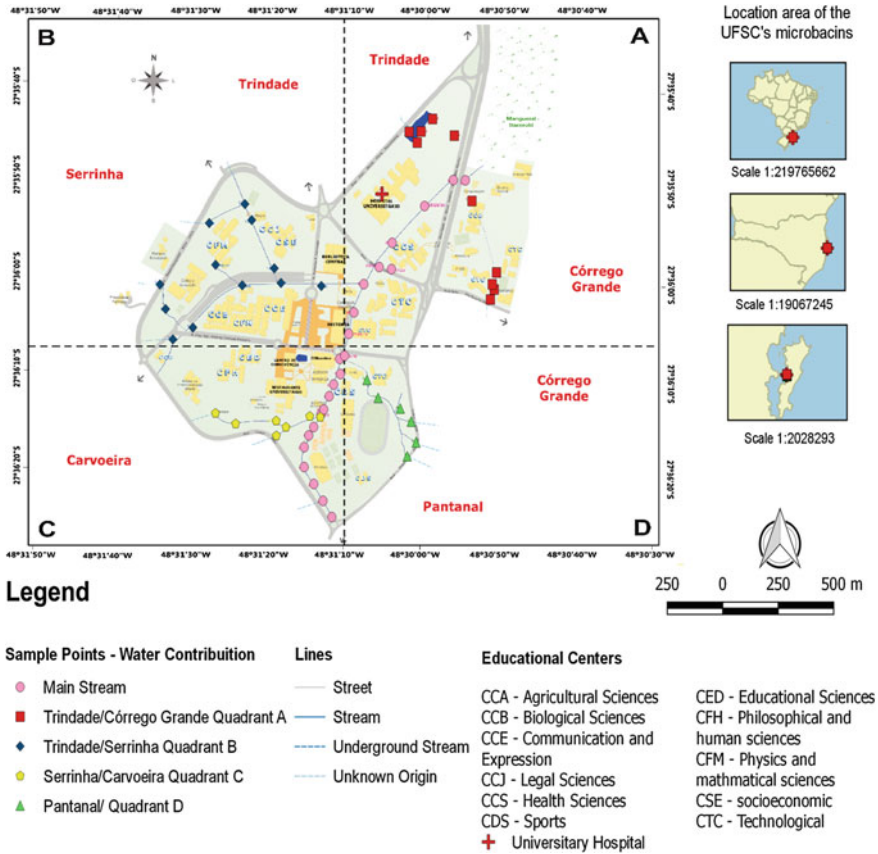


Fig. 1 72 hydrographical contribution points within UFSC micro basin, divided by quadrants A, B, C, D, and “Rio do Meio”. *Source* Adapted from LABTATE base map: <http://labtate.ufsc.br/>. Georeferenced points overlapped in satellite image

points of water contribution were identified. Water contributions: every water flows from pipelines, ditches, channels, tributary streams or any other means merging into the main course, Rio do Meio. Every analysis was carried out on non-rainy days, and the volume of precipitation and atmospheric temperatures considered were those of two days before the field trips.

- (b) **organoleptic (color, odor, turbidity) and thermal characterization of the samples:** Odor, color, and turbidity characterization were sensorially obtained and were associated with a scale of values from 1 to 3 according to Table 2. Odor classification: the sample was inhaled immediately into the collection container itself by at least three of the team participants. Color and turbidity: an aliquot of the collected sample was versed inside a 250 ml Erlenmeyer flask up to the 150 ml mark and compared side by side, on white paper and under natural light, compared to another one containing distilled water. Water

Table 1 UFSC micro basin main characteristics (Adapted from LABDREN 1997a, b)

| Parameter | UFSC micro basin | Unit |
|-------------------------------------|------------------|--------------------|
| Drainage area | 6.023 | km ² |
| Hydrographic network length | 17.413 | km |
| Perimeter | 13.015 | km |
| Compactness coefficient | 1.48 | |
| Form factor | 0.294 | |
| Drainage density | 26.22 | km/km ² |
| Average length of runoff | 26.22 | km |
| Average mean slope | 0.18 | m/m |
| Max elevation | 446 | m |
| Min elevation | 1.3 | m |
| Drainage basin source elevation | 88.5 | m |
| Drainage basin mouth elevation | 4.7 | m |
| Distance from basin source to mouth | 3.531 | km |
| Total slope | 18.51 | m/m |
| Main river sinuosity | 79.7 | % |
| Highest Strahler's stream order | 4 | |

Table 2 Scale of values attributed to the odor, color, and turbidity of water samples collected in the micro basin of *Campus* UFSC

| Parameter | Sensory attribute | | |
|-----------|-------------------|------------------------|---------------------|
| | 1 | 2 | 3 |
| Odor | Odorless | Moderate to unpleasant | Very unpleasant |
| Color | Colorless | Gray or brownish | Dark brown to black |
| Turbidity | Translucent | Translucent to turbid | Very turbid |

Note Samples associated with numbers 2 and 3 were considered possibly contaminated by wastewater

temperature: obtained by immersion of Hg thermometer into the samples collected at the water contribution points.

4 Research Methods—Data Treatment

For data treatment, a few definitions were made, including:

- (a) **definition of environmental descriptors or indicators:** Conceptual model DPSIR was selected, interrelating the essential or primordial properties of the ecosystem to the urban expansion (environmental quality × living conditions). The choice of the environmental pressure indicators guided the others (state,

Table 3 Quadrants symbology representation for data displayed in Fig. 1

| Quadrant | Symbols | Neighborhood | Points |
|-------------|---------|-----------------------------|--------|
| A | ■ | Trindade/Córrego Grande | 1–11 |
| B | ◆ | Trindade/Serrinha/Carvoeira | 1–14 |
| C | ◆ | Carvoeira/Pantanal | 1–8 |
| D | ▲ | Pantanal | 1–7 |
| Rio do Meio | ● | | 1–32 |

impact/effect, response) after analyzing the significant characteristics of local elements, which attributes could describe both dimensions of stress on the environment and aspects related to environmental sustainability, and living conditions of surrounding population (impacts, responses). All of the indicators (pressure, status, impact, response) are followed by the IN, EX or IN/EX labels, which respectively mean: UFSC indicator, indicator external to the UFSC Campus, and indicator for both.

- (b) **graphic expression of results:** the 72 sampled points, previously photographed and georeferenced were recorded cartographically, overlapping the quadrants of the generated map, from the modification of a map produced by LABTATE/UFSC. The spots were previously positioned on the area's satellite image using Google Earth software. The micro basin was divided into four quadrants, each one containing a main streamflow. The quadrants relate water contributions of external sources (neighborhoods around the *Campus*) or internal to UFSC, to the tributaries of and to Rio do Meio (Fig. 1). The sampling points respect an individual numeration, in ascending order, into the direction "Neighborhood-Rio do Meio". Rio do Meio, through crossing the *Campus* and being present in several quadrants, received a number and color of its own, regardless its position. Table 3 represents how each quadrant was displayed in Fig. 1 data.

5 Discussion of Research Findings

The circumstances of non-existence of an interdisciplinary team and basically formed by undergraduate students, therefore technically limited, imposed an alternative formulation: to design a project which focus on the object of study was transdisciplinary.

The unified motivation of the team revolved around two aspects: the inexistence of a socio-environmental policy guided by the institution, reflected in the inefficiency of sectoral policies for internal environmental demands in relation to the *Campus* environment; The aspiration of students majoring in Sanitary and Environmental Engineering for a model of "Sustainable UFSC".

From the pedagogical point of view, we sought to adopt a holistic approach to address the complex interrelationship between society and nature and, technically, delimited the microbasin of UFSC *Campus* as a unit space fundamental to the study.

Itacorubi HB has been undergoing an uncontrolled urbanization mainly since the 1980s. This uncontrolled advance exerts pressure on forest ecosystems and mangroves, demanding investments in inspection and basic infrastructure by public authorities. The deficiency of the adopted public policies is reflected into the increase of the environmental and social degradation: deforestation on slope instability; increase in population density; occupancy of environmental preservation areas; formation of areas of poverty generating neighborhoods or areas with poor housing standards and basic infrastructure; increased crime rate; insufficient basic sanitation services (drinking water, sewage, urban drainage, and waste management); contamination of waters in rivers and streams which are form the Itacorubi Hydrographic Basin and UFSC *Campus* microbasin.

The environmental dimension of the disorganized expansion over the microbasin, resulting from socioeconomic factors (unequal distribution of income in Brazil, rural exodus, lack of municipal territorial and environmental planning), generates pressures and impacts, even to different degrees, on the ecosystem. The runoff drained to the microbasin, originated mainly in the surrounding hills, flow to the lower parts forming new streamflows delineated by occupation and deforestation, and follow towards the formation of a central river that crosses the *Campus*, “Rio do Meio”. Rio do Meio, in its flow, receives contributions from tributaries until it meets the mouth at Itacorubi Mangrove. Soil sealing, deforestation, and lack of sanitation have increased the volume of runoff and flooding of lowland areas, the contamination of surface waters by sewage effluents, erosion and silting of canals, contamination of Itacorubi Mangrove, besides other calamities (Cristo 2002).

The social dimension of this type of urban expansion assumes even greater proportions, given that “the environmental conditions affect human health and well-being, both directly, for instance through pollution, and indirectly, through adverse effects on ecosystems, biodiversity or even natural Disasters and industrial accidents (Eurostat 2015). From the point of view of human relations, degradation is expressed in the increase of robberies and drug traffic, indicating high crime and lack of public safety.

Although the monitoring of physico-chemical and biological parameters has not been carried out, which certainly limits construction of indicators and may make it impossible to analyze the sensitivity of state indicators in relation to changes in the pressures that will guide management actions, this project considered that the DPSIR (Driving Forces, Pressures, State, Impact, Response) conceptual model allows preliminary proposition of environmental descriptors, from observations of environmental phenomena and some measurements in the field, as well as analysis of physical, chemical and biological data. 72 water contribution points were identified, some of which not previously recorded, possibly due to the lack of

relevance. However, from the environmental point of view these small contributions can not be neglected and therefore were considered by this study.

It was evidenced by the analysis of bibliographical data that the set of pressures and impacts occurring in the microbasin is a result of social inequality. In this case, this inequality is locally aggravated by the lack of urban planning and investment in basic infrastructure. However, the indicators suggested in this study intend to focus on the pressures to propose a monitoring program and actions that can mitigate the environmental and social impacts in the area.

It was also verified that it is possible to treat the indicators in three areas: (a) internal (IN)—where the pressure and impacts are derived exclusively from the UFSC and therefore the responses are the initiative of the institution; (b) external (EX)—where the pressure and impacts come from the neighborhoods and whose response requires the intervention of governmental powers and the supervision of environmental agencies external to the UFSC; (c) Mixed (IN/EX)—where pressures and impacts may be (or not) generated internally, but the response depends on actions that may or may not include UFSC and an external institution.

During the field study, the division of the quadrangle microbasin showed that there were similarities between them so that it was possible to propose a set of general descriptors rather than specific ones per quadrant. In all quarters, critical points of significant impact on public health, socio-cultural and landscape heritage, the quality of specific ecosystems, and the local economy were identified.

The descriptive pressure chosen to express environmental and social degradation of the area was the urban expansion, with pressures on: land use and occupation, water resources, and basic infrastructure and public safety. The most expressive and visible impacts of the pressure on land use are: irregular buildings, deforestation, erosion, frequent flooding, landscape disintegration and landfill of the Itacorubi Mangrove.

Morphometric characterization of the hydrographic basin is an important study in hydrological or environmental analyses, and aims to elucidate the issues related to the local and regional environmental dynamics, especially in relation to erosion and floods. However, the hydrological behavior of a HB is not only a function of its geomorphological characteristics and its type of vegetation, but it is also affected by anthropic actions, since interventions in the natural environment interfere in the processes of the hydrological cycle. In this sense, UFSC is not only one of the most important institutions within the Itacorubi Basin, but it is a major responsible for the pressure on the real estate expansion of the region.

The loss and degradation of the mangrove habitat, by occupying its area for urban expansion in general and that of UFSC buildings in particular, is a critical problem for the University. Some examples of how UFSC interfered in this environment in the past, even legally supported,¹ were: the construction of aquaculture

¹Since 1969 UFSC has been legally in possession of the Itacorubi Mangrove, granted by the Federal Government by Federal Decree No. 64340 for “housing the Teaching and Research Centers and other planned bodies, due to the new concepts of the University Reform...”. Since

tanks of the Department of Aquaculture (CCA), now deactivated; the building Institute of Biomedical Engineering; the construction of an animal house and a Central Warehouse; and the channeling and rectification of several watercourses. More rectilinear courses tend to carry more sediment and export suspended material to the mangrove.

Impacts related to land use and occupation, such as erosion and flood events were verified in the *Campus* microbasin. Floods are quite frequent, especially during the summer (Vieira 2007). Erosion processes in the basin were located mainly in the C quadrant, and in less crowded areas, on the banks of the unpaved canals, where the tree roots then emerged.

The intensity of soil water erosion depends mainly on rainfall, soil type, topography, and vegetation cover. Therefore the relationship between rainfall erosivity and soil erodibility, when combined with deforestation, is substantially increased and the erosion process accelerated. In addition, the microbasin has low drainage capacity, a low slope relief, shallow channels and rocky or waterproof soil, which makes it difficult to infiltrate and then favors runoff. As a result, there is greater susceptibility to flooding and erosion, especially when receiving high volumes of water during rainfall. It is possible to discipline the streamflow by containing the banks on one hand and, on the other hand, to facilitate the infiltration of the water in the soil, besides providing growth and the increase of the soil cover with proper vegetation for eroded soils.

UFSC Master Plan, presented in 2013, showed the territorial occupation rates for buildings and preserved areas, and the potential of using the territory still available in the *Campus* microbasin. So there is a call to take it back immediately. The evidence, however, is that the entire microbasin is in permanent modification and urbanization, and that its expansion totally lacks planning.

The environmental pressure descriptor “water resources and infrastructure” is also applicable in all of the four quadrants. Although the greatest contribution to changing water quality comes from the surrounding districts, there is also the contribution of UFSC itself.

Until 2003, prior to the connection to the insular sewerage network of Florianópolis, part of the effluents served by UFSC (laboratories, kitchens, toilets, etc.) were collected in septic tanks. However, some of these effluents, mainly small kitchens and some laboratories, were dumped into pipes flowing into the channels of the microbasin that flows into the Mangrove. During the field research, it was verified the existence of points of wastewater into the streams, which seem to originate from nearby UFSC buildings: the cooling system of the CERTI Foundation’s power plant, the University Restaurant, the Publisher of UFSC and the Centers of Education CSE, CFM, CCS and CDS.

Water from the streams and pipes from surrounding neighborhoods, which enter the *Campus*, were characterized as containing wastewater. This was justified by the

2002, with the creation of the Itacorubi Mangrove Municipal Park, mangrove management is being shared with the Florianópolis Municipal Government.

foul odor, milky and grayish coloration, and presence of foams. Inside UFSC *Campus*, contaminated water runs through the channels in shallow water mirrors and waterproofed grounds, covered with mud.

The color and odor of water inflows outside *Campus* showed clear indications of contamination by sanitary sewers. The waters of natural courses—when there's prevalence of organic colloids (humic and fulvic acids) and inorganic compounds such as iron and manganese oxides—appear brownish, but translucent and odorless. When water is contaminated with domestic effluents, it predominates colloidal matter and other materials that cause turbidity and a characteristic coloration, generally grayish and milky, as well as foam.

Temperature variations are part of the normal climate regime, and natural water bodies exhibit seasonal and diurnal variations, also varying according to flow and depth. In this way, its temperature is close to atmospheric or lower. When contaminated by industrial or domestic effluents, temperature is generally higher than that of running water. In this sense, it was considered that waters which had a temperature higher than atmospheric one had a great possibility of receiving waste water.

For the pressure indicator related to “water quality” and “basic infrastructure”, it is possible to act on state indicators. According to the type of pollution expected, it is possible to propose the variables to be monitored. By associating the legal compliance indicator (CONAMA 2005), which is an obvious criterion because one of the aspects always present in a management process is compliance with legal regulations, a good degree of balance was achieved in the relationship between the state Ecology, aquatic quality and public health. Moreover, the association between the indicator of pollutant loads and that of compliance with the legislation is particularly interesting, since it not only identifies possible non-compliance with legislation, but also points out situations that require special attention.

In addition, the state indicators: “pollutant loads” (for domestic sewage, gas station effluents and mechanical workshops, and pesticides used in combating vectors or in family farming), “dilution capacity” and “compliance with Legislation” take into account the possibility of pollutants generated in local economy and the fight against vectors for public health, the sensitivity of the water body to pollutant loads (residence time and concentration) and legal control over generators.

Finally, the descriptor of “public security”, originated externally to the Institution, exerts its influence on life quality of the university community in two ways: directly within the Institution's territory; and outside, because a significant part of it inhabits the surrounding neighborhoods. The urban occupation of the Itacorubi HB area is characterized by a high population density of diverse social composition, which also conditions the analysis of urban pollution. In lower areas of the basin, we have denser neighborhoods, due to verticalization of residences and a strong composition of middle and upper middle class, sectors (Trindade; Carvoeira; Pantanal; Parque São Jorge; Itacorubi; Morro do Mangueirão in Pantanal; Morro do Quilombo in the Itacorubi; Morro da Cruz near the Penitentiary; and Morro da Serrinha near Carvoeira and Trindade) of smaller population density

due to the horizontal residential units, but not less clustered, since properties are small. By reproducing what is happening in large cities, workers, students and criminals, especially drug traffickers, co-inhabit; the last ones identifying potential young clients in these neighborhoods. UFSC has programs that help drug users of the university community and outside it an unofficial program of car washers. However, for acts of vandalism, robbery and drug trafficking, which are becoming more frequent, only palliative proposals such as, for example, the isolation of the Institution by fences or ostensive policing are suggested. A Global Institutional Socio-Environmental Political Project (GISEPP), which performs the interface of the university community-local community environment, could be an alternative capable of coping with the social pressures that contribute to the degradation of the general quality of the environment and, finally, affect the Biodiversity.

Table 4 Environmental indicators proposed for the micro basin system at UFSC *Campus*

| Descriptors | | Indicators | | |
|-------------------------|-------------------------|-----------------------------------------------------------|---------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| Forcing | Pressure | Impact | State | Answer |
| Disordered urban sprawl | Occupation and land use | Suppression of mangrove area (IN; EX) | Habitat loss and fragmentation (Biodiversity) (IN; EX; IN/EX) | Institutional social and environmental policy from UFSC (IN) |
| | | Irregular constructions (EX) | % Deforested area (IN; EX; IN/EX) | Master Plan of the UFSC <i>Campus</i> (IN) |
| | | Occupancy of risk areas (EX) | N. of floods (IN; EX; IN/EX) | City Master Plan (EX; IN/EX) |
| | | Ditches with black and gray sewage runoff (IN; EX; IN/EX) | Geomorphological changes (IN; EX; IN/EX) | Reallocation of the composting system (IN) |
| | | Habitat loss and fragmentation (Biodiversity) (IN/EX) | Composition and soil type (IN; EX; IN/EX) | Monitoring and management of the mangrove (IN/EX) |
| | | Erosion points (IN; EX; IN/EX) | % Area eroded in the CFH forest (IN) | Development of projects and curricular subjects in the area of knowledge (IN) |
| | | Floods (EX) | Population density (IN; EX; IN/EX) | Development of inter and transdisciplinary research and extension projects for the micro basin environment (IN; IN/EX) |
| | | Deforestation (IN; EX; IN/EX) | Migratory flow (IN; EX; IN/EX) | Depletion of the micro basin and the Mangrove (IN; IN/EX) |

(continued)

Table 4 (continued)

| Descriptors | | Indicators | | |
|-------------------------|------------------------------------|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|----------------------------------------------------------|
| Forcing | Pressure | Impact | State | Answer |
| Disordered urban sprawl | Occupation and land use | Expansion of CAMPUS (IN) | N. of households served with water supply, sewage and garbage collection (EX; IN/EX) | Social registration (EX) |
| | | Composting system (IN) | Quality of housing | Public policies of urban settlement (EX) |
| | | Stagnant pond HU (IN) | | |
| | | Landscape disintegration | | |
| | Water resources and infrastructure | Water contamination (IN; EX; IN/EX) | Water quality parameters (CONAMA, 357/2005) (IN; EX; IN/EX) | All of the above and MORE: |
| | | Waterproofing of soil (IN; EX; IN/EX) | % Deforested area (IN; EX; IN/EX) | |
| | | Basic infrastructure (sewage, potable water and waste collection) (EX; IN/EX) | N. of households served with basic sanitation (water, sewage and waste collection) (EX) | Restructuring of the use and quality of HU pond (IN) |
| | | Insect proliferation (EX; IN/EX) | Capacity of water course dilution (IN; EX; IN/EX) | Restructuring of the drainage system (IN/EX) |
| | | Decrease in the use of the forest area of the CFH for leisure (IN; IN/EX) | Organic and metallic pollutants (IN; EX; IN/EX) | Monitoring of waters in the watershed (IN) |
| | | Pollutants of external economic activity (EX; IN/EX) | Drainage system (EX; IN/EX) | Inspection of polluting economic activities (EX) |
| Disordered urban sprawl | Water resources and infrastructure | Legal disagreement (IN; EX) | Water flow on canals (IN; EX; IN/EX) | Permanent collection of solid waste from the canals (IN) |
| | | | Canal height variation (IN; EX; IN/EX) | Restructuring of use and quality to the UFSC Forest (IN) |

(continued)

Table 4 (continued)

| Descriptors | | Indicators | | |
|-------------|---------------|-------------------------------------------------|-------------------------------------------------------------------------------|---------------------------------------------------------------|
| Forcing | Pressure | Impact | State | Answer |
| | Public safety | Increased theft and robbery (IN; IN/EX) | N. of students and/or care of users of legal and illegal drugs (IN) | Construction of the UFSC bicycle rack (ARQ/UFSC project) (IN) |
| | | Decrease of external leisure areas (IN) | N. of workers and/or service of users of legal and illegal drugs (IN) | Internal policy for coping with drug use (IN) |
| | | Trafficking and drug use (IN; IN/EX) | Level of forest use for leisure (IN) | Policy to combat drug trafficking (IN; IN/EX) |
| | | Precarious housing for low-income students (IN) | N. of indoor and outdoor leisure areas at UFSC (IN) | Master Plan for UFSC (IN) |
| | | Accessibility of disabled people (IN) | Quality of student housing (IN) | |
| | | | N. of students attended with scholarships (IN) | |
| | | | N. of health care of the population due to infection or infection (EX; IN/EX) | |

Note (IN) refers to UFSC indicators. (EX) refers to external indicators. (IN/EX) refers to indicators for both UFSC and external

The socio-environmental indicators suggested and presented in Table 4 can assist in the evaluation of natural and anthropic impacts of occurrence in the area, and collaborate in a Management Plan for the Itacorubi Basin/UFSC *Campus* Microbasin.

6 Conclusion and Recommendations

The Itacorubi HB, from the hills to the Itacorubi Mangrove, shows signs of compromise, particularly accelerated by uncontrolled urban sprawl. This unbridled advance translates into indicators of environmental and social degradation in the basin such as: deforestation of slopes; increase of population density in areas of environmental preservation by migratory flows; lack of sanitary infrastructure; water pollution; formation of concentrated areas of poverty; increased crime, among others.

For the basin scale the use of indicators is desirable as a tool for Itacorubi Basin Management Programs, as well as for UFSC *Campus* Microbasin. Systematic

monitoring of water quality is a procedure that will allow monitoring the performance of the suggested response and pressure indicators.

One of the important results of this research, was to have been an inspiration for Central Administration of UFSC, that between 2012 and 2014, promoted two projects, still in progress, very important for the environmental quality of the *Campus* microbasin and nearby neighborhoods.

Despite this, much still needs to be done by the institution. The construction of an environmental policy by UFSC may generate programs outside the university, it is recommended a set of corrective and proactive educational and technical actions in the environmental, public health and basic sanitation fields: an integrated monitoring program, involving UFSC, and municipal and state environmental agencies from Itacorubi HB and *Campus* UFSC micro basin; redefinition and rehabilitation of the UFSC micro basin; a geographical approach regarding land use planning; an ecological approach to ensure a new ecological balance; and, finally, social and ethical approaches to ensure social well-being through physical spaces.

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