HIGHWAYS AND NATURAL CATASTROPHES IN SANTA CATARINA (BRAZIL)[1]

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ABSTRACT

The state of Santa Catarina (located in southern Brazil), due to its geographical position, is constantly affected by several climatic events, such as intense rains, droughts, extreme temperatures, tornadoes and hurricanes, which consequences might not only be deaths but also flooding and landslides on hills placed by roads. Although Santa Catarina stands out as an important industrial area, just like the entire southern region of Brazil, government and enterprise segment disseminate that there is a lack of resources for transport infrastructure investments, preventing a more significant economic growth. Highway transport would be the most dramatic obstacle, as the expenditure with early change of tyres and equipments, excessive consumption of fuel, speed reduction and traffic interruption due to lane problems caused by climatic events increase freight costs in Brazil. Therefore this study analyses the dimensions of the problem, tracing a diagnosis of the main road network in north-south and east-west direction: BRs 101, 116, 282, 280 and 470. It must be highlighted that right after Novembers (2008) rain and landslide catastrophes, a fieldwork on the already mentioned roads was carried through based on landslide spots and high-risk areas surveys, with the respective mapping (identification of geographical coordinates using GPS) and photographic record, resulting on a total of approximately 3.200 km of highways. Santa Catarina feels the difficulties imposed by the natural conditions that compose its landscape. This reality turns highways construction, conservation and maintenance too expensive, especially on the atlantic valleys, where are located many important industrial zones. Accentuated relief, typical storms of the subtropical climate, intensive land use, sometimes made incorrectly if

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related to its natural properties, are some of the reasons that involves and keep involving various problems that endanger lane's quality. Floods, landslides, early erosion and lane's destruction are recurrent happenings on Santa Catarina's highways. But it is important to note that 90's neoliberal juncture brought the increasing abandonment of transport infrastructure, commencing the process of privatizations and concessions. The main highways used to intra and inter-states transport present serious maintenance and crowding issues, hard access to ports, elevated number of accidents etc., whose solutions have been based only on road duplication and management concession to foreign private initiative. Santa Catarina's economic development, stunted by the lack of transports infrastructure investments, has been coming up against the global economic crisis in a positive way. But Santa Catarina's industrial exportations could have better competitiveness if the problems concerning maintenance and engineering work aiming to reduce natural catastrophes consequences were healed.

Keywords: natural catastrophes, highways, Santa Catarina-Brazil, diagnosis.

INTRODUCTORY NOTES[2]

The present spatial organization of the transport nets (highways, ports, railways and airports) of Santa Catarina State (Brazil) is related with the territory occupation processes, determined by the natural scene conditions, mostly the relief and hydrography, and with the evolution of the development of the economic activities and the political relations established.

The State of Santa Catarina, with about 6.052.587 inhabitants (estimate 2008) distributed among 293 cities, with Gross National Product *per capita* of US$10,572, is located in the southern portion of Brazil, between the parallels 25°57'18"and 29°21'07" of south latitude and between the meridians 48°19'37" and 53°50'12" of west longitude (Picture 1).

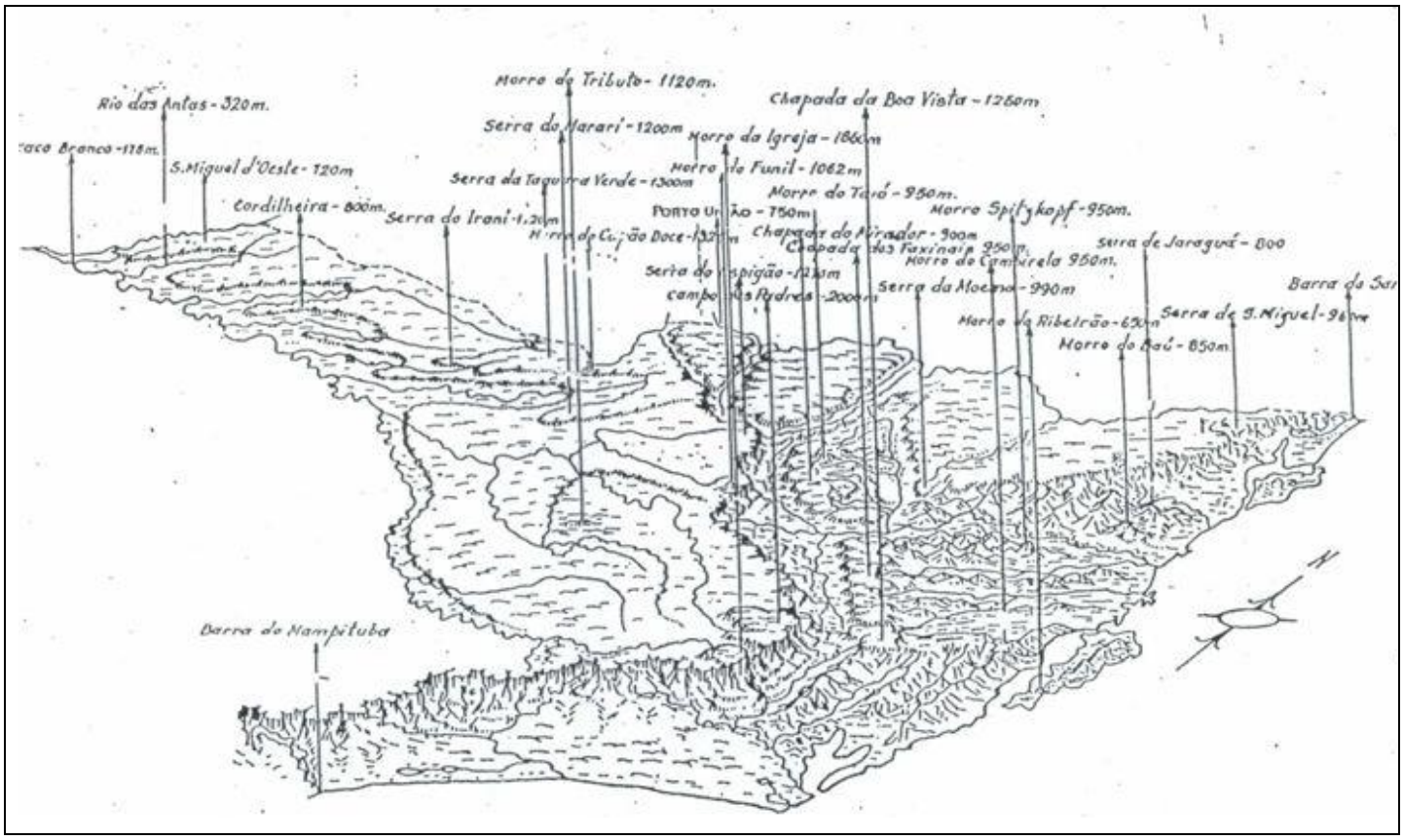
Together with the States of Paraná and Rio Grande do Sul, Santa Catarina integrates the Great South Region. Even being the smallest State of the South Region, with 95.346,18 km², 1,12% of the Brazilian territory and 6,57% of the South Region, Santa Catarina presents a territorial area equivalent to countries of the European Union, such as Austria, Belgium, Holland and Portugal (Santa Catarina, 2010). The great distances and the relief diversity complicate the implantation and managing of the transport infrastructure demanding a significant financial assistance, which is not being carried out neither by the state government, nor by the federal government.

As to land modal study, the relief becomes an agent of great importance. Around half of the Santa Catarina State territory is composed by the Southern Plateau, which also extends to significant part of the neighbor states territory of Paraná and Rio Grande do Sul. So, Santa Catarina presents a dual physiographic compartmentalization (Picture 2) that led the occupation and settlement processes of the territory: the region of the Plateau, a wide

[2] The text contains reflections presented in Rocha *et al.* (2009).

west downward tableland up to the border with Argentina, whose rivers run to the Prata basin; and the region of the coastline and downhill's, an extensive area that develops from the border of the plateau up to the sea, formed by important independent hydrographic basins, whose rivers flow directly into the Atlantic Ocean. (Peluso Júnior, 1991, p.15)

Picture 1 – Political administrative division of the State of Santa Catarina and its location in South America.



Picture 2 – Hand drawing of the State of Santa Catarina, highlighting the coastline's slope and the plateau's slope (Peluso Júnior, 1952)

The coastline and downhill's' slope and the plateau's slope are separated by mountain ranges of different geological formation, which also determined the geomorphological compartmentalization of both regions:

1. The Sea Mountain Range is located in the northeast portion of the state. It extends along the Brazilian coastline, cutting through the States of Espírito Santo, Rio de Janeiro, São Paulo and Paraná, ending in Santa Catarina's northeast, in the city of Joinville. This Mountain Range, close to and parallel to the Atlantic Ocean, is composed by very high mountains and steep downhills formed by igneous and metamorphic rocks. A testimony of this formation, named Santa Catarina's East Mountain Ranges, appears southwards from the city of Garuva (northeast) up to the vicinity of Jaguaruna city (middle south shore), in the shape of seas of hills inserted by mountain sets. Together with these formations of crystalline origin there are recent sediment deposits as the riverine lowlands of the various important rivers that flow directly into the sea and the coastal lowland. The coastal lowland, from Garuva (northeast) to Laguna (middle south shore) is interrupted by the several elevations of the Santa Catarina's East Mountain Ranges. Due

to the presence of these hills close to the sea, many cliffs, beaches, coves and bays were formed. They are very popular in the summer for tourism. From Laguna (middle south) heading southwards up to the border with Rio Grande do Sul State, the coastal lowland is very wide presented, with the formation of a wide straight beach, with coastal lagoons and vast dune fields cut through by the river mouths of the Atlantic rivers.

2. The biggest part of the Plateau is separated from the coastline by the so called General Mountain Range, which in fact is not a mountain range, but and extensive acclivity formed by a sequence of layers of sedimentary rocks, inserted with basaltic lava flow layers (Gondwana), mostly known as White Column (geological monument that enhanced the Theory of the Continental Drift). From the High Valley of the River Itajaí-Açu (in the middle part of the State) where there are elevations with flat tops and downhills in the shape of acclivities (similar to tables or tablelands cut through by inserted valleys). Heading south, there are the most elevated areas in the state, 1,827 metres high, in the Boa Vista Hill, between the cities of Bom Retiro e Urubici. From this place, a long and high cliff extends up to the border with Rio Grande do Sul, where valleys deeper than 500m are located. They are real canyons, as the one of Itaimbezinho, in the extreme South. In the upper part of this long downhill, is the South Plateau. This compartment presents its higher altitudes together with the middle south portion of the acclivities of the General Mountain Range, where there are also the flattest lands. Heading southwest the altitude decreases gradually, when, after a long distance of approximately 600km in a straight line, gets to 200 meters high, on the border with Rio Grande do Sul and Argentina, inside the South American continent. Mostly, the rock that emerges in the plateau is the basalt, original from lava flows, which formed a red and clayey soil. The lands are dissected along the several rivers of the basin of Uruguai and Iguaçu rivers. The shapes of reliefs are very active, because the elevations are narrow and with flat or convex tops and its downhills are steep, with deep inserted and winding valleys. The downhills of the valleys present plateaus (steps) original from the erosion that went through different layers of basaltic flow.

Determined by the natural picture, the form of the territory occupation of Santa Catarina ended up configuring areas with predominant a) small properties in the coastal zone, inside the valleys of the Atlantic slope and of the Santa Catrina's West; and b) domain of large pastoral properties distributed along the east portion of the plateau.

The forest areas with very rough relief, characteristic of the Atlantic valleys (rivers Itapocu, Itajaí, Tijucas, Tubarão, etc.) and the most western affluents of the Uruguai river (Peixe river, Chapecó, etc.) in the West of the plateau, become economically viable with the overcoming of the natural difficulties (bushes, valleys, hills, etc.) by means of an occupation with numerous small properties, worked by the family's productive labor force. Those families are mainly formed by German, Suisse, Italian and Polish immigrants and their descendants from Santa Catarina and Rio Grande do Sul. These small properties areas, with higher demographic density, developed through the XXth century important industrial fields (textile, agro-industrial, metal-mechanic, electric, etc) from local crafty initiatives.

The flat areas, covered by natural fields and the Araucaria Forest from the east edge of the plateau, influenced the implantation of large Portuguese-Brazilian pastoral properties in the XVIIIth and XIXth centuries. In this area, the colder weather due to the higher altitude, causing a slower regeneration of the pasture, determined the larger size of the properties extensively explored under production relations with feudal characteristics. Herding was gradually placed by the intense lumber extraction in the XXth century, mainly of the native araucaria pine tree for exporting and use in paper and cellulose industries. As the local forests almost disappeared, a giant forestry of *Pinnus elliotis sp.* was established in order to supply the big paper and furniture industry and also the foreign market.

The construction of the major railroads in Santa Catarina occurred in the end of the XIXth century and in the early decades of the XXth. It played great role in the outflow of the production to the coastal ports and to the markets of southeast, promoting economic dynamism of the regions with the presence of small market production. Mamigonian (1958) reminds that "the railroads of the '*Rede de Viação Paraná Santa Catarina'* which, besides that stretch [São Paulo-Porto Alegre], make the connection of the Canoinhas Plateau with the Industrial Center of Joinville and the port of São Francisco do Sul, represent an important role in the outflow of the agricultural products from the countryside. In the coastal valleys, the agricultural products outflow more by road transport."
With the political and economical changes occurred since the 1930's (The 30's Revolution/Vargas), the sequent governments started to work with plans of economic development that included the infrastructure planning characterized by the preference for the highways. This preference was expressed in the reports and messages of the governors.

Rangel (2005, p.518 and 519) comments that around this time "the nation felt that, above all, it needed highways, automobiles, buses and trucks" and that the spontaneous tendency to road planning was the best for that initial period of industrialization, because there was no "single railroad system, but various regional systems different from each other, orienting the product flows" to the exporting ports located in the Brazilian coastline. That is, because the industrialization demanded unification of the national market, in order to ensure the minimum scale compatible with the industrial projects "the railroad section was a factor of resistance against the market unification". It was so because railroads did not make this integration of regions. The author highlights that, as "the interregional transport flows would become heavier and incompatible with the road means", the railroad transport would start to impose its advantages, as it starts to reveal in the present days.

The dissemination in the peripheral countries of neoliberal economic policies imposed by the the American imperialism, implanted in Brazil since the governments of Collor and Fernando Henrique Cardoso in the 1990's, resulted the privatization/concession of the country's transportation infrastructure system, mainly railroads and highways. In Santa Catarina, the case of some federal highway stretches like BR 101 and 116 is cited.

HISTORICAL ASPECTS

The old Troops' Path (*Caminho das Tropas),* in the plateau, today the Federal Highway BR116, was an important economical route that linked the south of Brazil to the country's mining center, so it started to meet de demand of beef and traction animals (cattle and mules) abundant in the southern region since the time of the Spanish Jesuit missions. Along this path small cores of settlement, inhabited by farmers, emerged. They increased the development of Santa Catarina's plateau.

The coastal cities linked each other by a primitive route along the lowlands and the coastal hills without major regional importance. That is because the main means of transportation between these cities was by sea, enhanced by the natural conditions (protected waters) existing in Santa Catarina's coastline for the installation of ports.
The European immigrants that arrived in Santa Catarina since the XIXth century, started to occupy the Atlantic Valleys, beginning the construction (sometimes reopening) of roads that followed the flow of the rivers in the direction of the plateau, which oriented later the installation of the present east-west highways.

The main connections between the plateau (The Troops' Path) and the coastline were made by paths that followed the hydrographic basins oriented to the Atlantic Ocean. Their pioneer outline served for the implantation of the contemporary paved roads. Highlighting a) in the northeast, the path that connected the Port of São Francisco do Sul to the northern plateau, up to Mafra – present BR-280 and SC 301 (Dona Francisca Road, Picture 3) b) in the middle north, the path that connected the Port of Itajaí, passing through the Itajaí-Açu River Valley, up to Curitibanos – present BR – 470, and c) in the center, the path of the State Capital (Florianópolis) up to Lages, that passed through the Cubatão River Valley – present stretch of BR – 282; and d) in the south, the winding road that connected Lages to the coastline – present SC – 438, The Road of Trace River (*Estrada do Rio do Rastro*). (Picture 4)

Picture: *A Notícia* (2010)

Picture 3 - *Estrada Dona Francisca* (northeast)

Picture: Varlei Mariot (CPRM, 2010)

Picture 4 - *Estrada do Rio do Rastro* (south)

During the three first decades of XXth century the road net of Santa Catarina grew considerably. The pioneer paths opened along the previous centuries were the main ways that guaranteed the outflow of the production and the connection of the main regions of the state with its capital and coastal ports.

The natural cut that the landscape of Santa Catarina presents demanded the elaboration of major engineering works that ended up generating for the state high expenses for its construction and maintenance, becoming a limiting factor in the projects of increasing the road net.

The new highways that were opened in the beginning of the XXth century appeared in the region of the plateau and West of Santa Catarina, executed by colonizing companies that acted in the settlement of the state's west.

They were mainly roads that interconnected the new cores of occupation among themselves and with the São Paulo-Rio Grande railroad. The relation established between the state government and the settling companies was consolidated through agreements in which the construction of the roads was guaranteed by the companies provided that the government supplied available lands along the roads that should be destined for lot division to be sold for the settlers that were asking in the area. After the end of the construction, the maintenance and conservation of the roads were carried out by the government. (Message of the Governor Vidal José de Oliveira Ramos, 1912)

The construction of the roads was carried out while the agreements were signed. There was no road planning of the state, what caused afterwards a series of expenses for the state government, since many roads were built without a previous engineering and budget study that would guarantee the viability of the work. (Message of the Governor Nereu de Oliveira Ramos, 1936).

In 1936, the state road plan was approved, which made possible the execution of several works of reconstruction of roads that did not have an adequate outline and also prohibited new concessions that did not present the study organization and previous budgets.

In the end of the Vargas era and in the beginning of JK's government (1950's), despite the close relation established with the United States in a period of increasing of the world's economy, the process of industrialization strongly continued related with the plans of national integration of Brazil. This continental country strongly invested in infrastructure and consolidated the option for the highways.

The growth of the economy and of the population in the cities of Santa Catarina evidently generated an increase of the local demands for new roads. In the 1960's the policies turned to the road network system foresaw the social and economical integration of Santa Catarina by means of trunk roads that interconnected the several regions of the state and enabled the quick access to the port system. The South, North and West regions of Santa Catarina were extremely linked to the neighbor states – Rio Grande do Sul e Paraná – and the improvement of the road system would help to revert this situation. (Message of the Governor Celso Ramos, 1961)

Until de 1960's, on the coastline, only the state road Jorge Lacerda, between Blumenau and the port of Itajaí, had asphaltic pavement. In the plateau, the BR-116, first federal highway cutting through Santa Catarina's ground, paved in the end of the 1950's, had the function of reproducing, in national terms, the role of connecting São Paulo to Rio Grande do Sul, replacing the old railway of The Contestado. "The BR – 116, longitudinal road, before BR-2, was one of the priorities of the national transportation policy in order to ensure immediate connection South-Southeast" (Lago, 2000, p. 231).

On the coastline, the Br-101, planned in the National Road Plan in the 1950's and concluded in Santa Catarina in the 1970's, finally interconnected the Atlantic industrial region of Santa Catarina to the rest of the country. In the next years, mainly in the 1980's, important connection road stretches (BR – 470 and BR – 480) and secondary roads (BR-280, BR-282), bringing the longitudinal trunks near (BR 101, BR 116), enabling the relations between the coastline and the plateau.

During the 1980's the state roads were enlarged, new stretches were built and paved in different regions of the state, according to the following Table I:

Table I – Santa Catarina's road network distribution (km) - 1985

ROAD	PAVED	NOT PAVED	AT WORK
Federal	2.375*	877	302 **
State	1.811	2.665	298
City	666	81.383	-
TOTAL	4.852	84.925	600

Source: Message of the governor Esperidião Amin, 1986. Extract of Rocha *et al*. (2009)

* 733 Km paved by the state government

**253 km being paved by the state government

The consolidation of the roads by the state territory ended up influencing in a negative way "on the sea and railroad transport. The ports of Florianópolis and Laguna were closed; the Federal Railroad Network Inc. (*Rede Ferroviária Federal S.A*), in the South, the old Dona Teresa Railroad, became transportation specialized in coal, did not receive passengers nor cargo in general; the Santa Catarina Railroad, from Itajaí to Trombudo Central stopped circulating" (Peluso Júnior, 1991, p. 276). However, Santa Catarina is the only Brazilian state that presents four exporting/importing ports in operation. They are the ports of: São Francisco do Sul (in the Babitonga Bay in the Island of São Francisco do Sul, northeast state); Navegantes (mouth of the river Itajaí-Açu); Itajaí (mouth of the river Itajaí-Açu); Imbituba. Another port is under construction by private capital in the city of Itapoá (northeast).

In the 1990's the disassembling of the state, by means of neoliberal economic policies, started to bring serious consequences for the transportation infrastructure, which did not receive significant investments, increasing even more the problems faced on the lanes.
The concessions started to be seen as the more adequate way to solve the chaos on the roads and railroads, and the small improvements investments were carried out by private companies.

The reflection of the Geographer Armen Mamigonian clearly presents the Brazilian situation in these neoliberal years and the destructive consequences for the vital infrastructures of the country:

> After the tragic years of neoliberal destruction (1990 - 2002) we retake the destiny of Brazil in our hands [election of Lula's government]. It is for us patriots and internationalists to give sequence to the construction of this extraordinary nation that amazed and is still amazing many foreigners of good will like Stefan Zweig, Orson Wells, Edgar Morin, among others. Nevertheless, we need to take into account certain important lessons, which we should know for long: 1) the privatization that was advised to us by Ignacio Rangel cannot be confused with the criminal selling of our estate, as it happened with CSN or the CVRD, supported by Aluísio Mercadante alleging that they were not strategic anymore ; nor it is duplicating highways (Fernão Dias, for instance) and

> passing it to the private finance initiative, nor it is privatizing Infraero [airport administration], etc. More importantly, to conduct the Brazilian private initiative, using national resources with multiplicative economic growth effects, to construct in PPP (public-private partnership) new airports, new road duplications , new electric power plants, new railroads, etc. and not simply bite the existing installations working well [...]. (Mamigonian, 2005)

Since 2007 The Program of Growth Acceleration (PAC) is in execution. It is composed by a series of economic measures that aim at accelerating the economy growth. The centerpiece of the investments is destined to infrastructure of transportation, but in Santa Catarina they are not bringing results enough to meet the economic growth.

THE PRESENT PICTURE OF THE HIGHWAYS AND THE RAINS IN 2008

The main highways that cut through the state of Santa Catarina are of federal jurisdiction. The highlighted ones are the longitudinal roads BR-101, which follows Santa Catarina's coastline, BR-116, which passes in the center of the state by the plateau's region and BR-153, which runs on the middle west promoting the connection of Santa Catarina with the other southern states, with other regions of the country and with the countries that integrate the Common Market of the South – MERCOSUL. There are also the secondary roads: BR-280 and BR-282 that, with an outline east-west, promote a historical and important connection between the coastline and the west of Santa Catarina, enabling the link with Argentina.

The road network of Santa Catarina is distributed, as in the other states, among federal, state and city roads under the responsibility of the city councils. (Tabble II)

Table II – Extension (km) of the road network in Santa Catarina (2005).

SITUATION	FEDERAL	STATE/ TRANSITORY	STATE	CITY	TOTAL
Planned	335,7	-	284,0	43.382,0	44.001,7
Not paved	29,7	248,6	2.099,0	52.977,0	55.354,3
At work	102,6	-	259,9	-	362,5
Paved	2.137,7	715,9	3.332,6	914,6	7.100,8
TOTAL	2.605,7	964,5	5.975,5	97.273,6	106.819,3

Source: DEINFRA. Extract of Rocha *et al.* (2010)

Since last decades, when an expressive population and economy growth is verified in the state and all over the country, the occupation towards risky areas also grew. The natural phenomena such as floods, landslides, gales, tornados and droughts started to cause damages and growing problems. The natural disasters existing in Santa Catarina are related to adverse climatic phenomena, mostly with the rain precipitation.

The natural disaster in the state are related to adverse climatic phenomena, such as the intense climatic rain precipitations. The humid subtropical climate of southern Brazil is directed by the beheviour of the the intertropical air masses (warm) and polar air masses (cold), which frequently colide over here. One should consider the *El Niño* that contributes for the occurrence of the major floods in the state. The ones of 1911 and 1983.

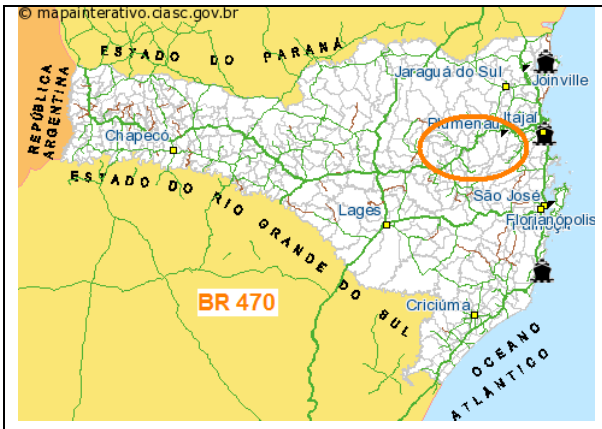
In November, 2008, the biggest tragedy already reported in Santa Catarina occurred due to three months of frequent rain. It covered one third of the state territory (63 city councils ordered Emergency Situation and 14 State of Public Calamity) affecting more than 2 million people and letting 78,000 homeless. Around 97% of the 135 deaths in this period were caused by burying.

The main cause of the mass movements was the soil creeping, and more than four thousand landslides were identified. Around 23 state roads and four federal roads were damaged.
Next, the general characterization and some pictures of the federal roads of Santa Catarina that were most affected by the rain in 2008 are shown. Field surveys were carried out around two weeks after the catastrophic events.

BR-470

The federal road BR-470, in Santa Catarina, promotes an important connection of the agro-industrial productive area of the state's west, with the ports of Itajaí and Navegantes, besides the airport, determining the outflow of one of the major world productions of birds and swine cattle. It is also the main road axis of the network of cities in the Itajaí Valley, a region of dense population, with about 1.000.000 inhabitants, and dynamic industrial activity. The road inicially runs the Itajaí-Açu river valley, characterized by winding stretches, passing through cities like Itajaí, Blumenau and Rio do Sul. After overcoming the levels of General Mountain Range, it arrives to Santa Catarina's plateau where the road has a predominantly straight outline, passing through the cities of Curitibanos e Campos Novos. The final stretch of the highway in the state's territory faces Uruguai River and from then on the road follows its route in the neighbor state of Rio Grande do Sul's territory.

The Transport Infrastructure National Department (DNIT) Will duplicate the stretch between Navegantes e Timbó; this stretch where the highway passes through the urban areas of many cities is quite winding, fact that demands a thorough and expensive engineering study.
The region where this road passes in the Atlantic slope is the stage, since the beginning of its occupation in XIXth century, of major floods of the main river, Itajaí-Açu, and its affluents.
When the first German immigrants were settling in Blumenau (century 19), in broad virgin forest, destructive floods occurred according to reports from that time. Since then, the intense tree cutting, of all hydrographic basin, enhances the masses movements and worsen floods due to the silting of the rivers. The rains of November, 2008, provoked major damages on the lane and the road was closed off in several stretches (Pictures 5 and 6).



Picture 5 – Pictures of mass movement phenomena in BR-470, in the vicinity of Blumenau, after the rains of Nov/2008. Date: December/2008.

Picture 6 – Pictures of mass movement phenomena in BR-470, on the banks of Itajaí-Açu river after the rains of Nov/2008. Note the car in the river. Date: December/2008.

BR-282

With its transversal outline, BR-282 cuts through Santa Catarina on the east-west way, connecting Florianópolis (the capital) to the extreme west (approximately 800km long), becoming the main via of integration between both state regions. Paving, started in 1977, was concluded in February, 2009, after 32 years. The asphalting of the 30km stretch from São Miguel D'Oeste up to the border with Argentina was done with PAC's resources. This long time of difficulties to get to Florianópolis determined the little polarization of the capital over the West of Santa Catarina, which fluctuated under the influence of neighbor capitals, Porto Alegre and Curitiba.

The inicial stretch of the highway, between Florianópolis and São José, is named *Via Expressa*, and it is the only duplicated stretch of the road and one of the busiest of the highway, since it is the way of access to the capital. On the stretch from São José to Palhoça, BR-101 overlaps and, since this city, it starts to have a simple and winding outline going through the Cubatão Valley. Arriving at the plateau of Santa Catarina the road becomes predominantly straight and it passes through the cities of Lages, São José do Cerrito, Campos Novos, (stretch where the highway overlaps BR-470), Joaçaba, Xanxerê, São Miguel do Oeste and finally, after 700 km, it ends in the city of Paraíso, on the border with Argentina. Together with this neighbor country, there will be a bioceanic highway. The stretch that goes through the valley of the Cubatão river, on the coastline, is about to be duplicated with the resources of the Acceleration Program (PAC) of the Federal Government. It was noticed that the damage caused in BR-282, in November, 2008, focused mainly on the downhills of the Santa Catarina's East Mountain Ranges, of crystalline bedrock. In the areas of sedimentary crop out, more landslides are recorded. (Pictures 7 and 8)

Picture 7 – Pictures of mass movement phenomena in different spots of BR 282, occurred during the rain of November, 2008. Date: December/2008.

Picture 8 –Pictures of mass movement phenomena in BR 282 (area of Great Florianópolis), occurred during the rains of 2008. Date: dec/2008.

BR-280

The road BR-280 is an important outflow of the production from the north plateau in Santa Catarina – region with significant production of furniture, cellulose and paper. The road begins in the sea, in the port of São Francisco do Sul island (Picture 9), continues through the valley of the Itapocu river where the city of Jaraguá do Sul is located (important electric and textile industrial pole), goes on towards northwest going up the downhills of the Sea Mountain Range where it becomes winding. It continues up to the north plateau, running through the cities of São Bento do Sul, Mafra – where it crosses highway BR-116 – and Canoinhas.

In several stretches BR-280 follows the railway, which equally connects the north plateau to the port. However the trains of the concessionary company (Latin America Logistics – USA) takes to the port mainly soybean (original from Paraná and Mato Grosso do Sul) and iron reels for a factory located a little before the port. Both modals have their ancient outline today running through the center of various cities in the area and causing accidents and big trouble.

Since the city of Porto União (north plateau) the highway is under the jurisdiction of state government and becomes a coincident road. In this stretch the outline of the road is narrower and in worse traffic conditions. Since Porto União, the road starts to go through Paraná state.

The duplication of the stretch from the valley of the Itapocu river to the port of São Francisco is planned. This port is one of the busiest of the highway. During the soybean harvest the lines of trucks, loaded with soybean, waiting for shipment, extends in many kilometers.

The records of mass movements in BR-280 in Santa Catarina happened on the stretch where the road goes up the Sea Mountain Range towards the plateau (picture 10).

Picture 9 – Pictures of mass movement phenomena in different spots of BR 280 occurred during the rains in 2008. Date: Dec/2008

Picture 10 – Pictures of the vicinity of the São Francisco do Sul port. Date: December/2008

BR-101

The BR-101 highway begins in the state of Santa Catarina, in the city of Passos de Torres on the border of Rio Grande do Sul state. It follows along the coastline passing through most of coastal cities of Santa Catarina - those bordering the sea. Due to the fact that it is an area of coastal lowlands, its outline is predominantly straight line, except in areas of rough relief when it passes through the elevations of the Santa Catarina's East Mountain Ranges.

BR 101 presents an intense traffic of cargo trucks and passenger carrying vehicles. Besides being a coastal corridor between the south and the rest of the country, it is the only passage to reach the several summer beach resorts of Santa Catarina. Also, to get to the four ports and to the most populated cities in Santa Catarina (Florianópolis and Joinville). It interconnects one of the most industrialized and urbanized coastal areas in South America, considering that the industry, intended for national and international markets, spread around many cities of the Atlantic slope. Those cities, in many cases, equally develop the touristic activity (festivals from European origin, beaches, adventure tourism, etc). This way, since its conclusion (in the 1970's), it is encouraging the growth and urbanization of the cities along its route. This fact has been generating an extensive area in process of conurbanization.

Both main longitudinal highways that cut through the state, BR – 101 (north stretch) and BR – 116 (north-south stretch in the central area of Santa Catarina) were given as concessions in 2008, for a period of 25 years, to *Autopista Litoral Sul* the first stretch and *Autopista Planalto Sul* the last one. These concessionaries belong to the OHL Brazil group (Obrascon Huarte Lain Brasil S.A) from Spanish origin. It represents, nowadays, the biggest group of road concessionaires in Brazil, also working in the states of São Paulo, Minas Gerais, Paraná and Rio de Janeiro. It also has the concession of different modals around the world.

It is 382,3km long the stretch given as a concession to the Spanish company for 25 years. It goes from the city of Palhoça (central shore) to the city of São José dos Pinhais (Paraná state). It had been recently duplicated with the resources of Federal Government. In Santa Catarina there are four tollbooths distant 65 km from each one.

Studies carried out by the Santa Catarina's Cargo Transportation Companies Federation (FETRANCESC) pointed at 34 items that were not clear in the contracts of concession of BR-116 and BR-101. Some flaws aroused, such as the one that allows extras in the toll tax, increasing its price up to 25%. The bid notice also allows an economic balance, that is, the company might raise the tax according to the new works that it carries out on the road. Another polemic point raised by FETRANCESC was the fact that the income come from the domain zones is no taken into account when calculating the tax.

On the episodes of November/2008 many floods and mass movements occurred in several stretches of BR 101 (Picture 11and 12)

Picture 11 – Pictures of the events occurred during the rains in 2008, BR 101 highlighted Date: dec/2008.

Picture 12 – Pictures of the events occurred during the rains in 2008, BR 101 highlighted Date: dec/2008.

CONCLUSIONS

The state of Santa Catarina, due to its geographic position, is constantly affected by diverse climatic events, such as intense rains, floods, droughts, extreme temperatures, frosts, hail, tornados, hurricanes and landslides. According to Marcelino *et al* (2006), the middle areas of the west of Santa Catarina, Itajaí Valley and Great Florianópolis are the most affected by the disasters. In the middle area of the West of Santa Catarina there is the highest number of cities of Very High Risk, followed by the middle regions of the Itajaí's Valley and Great Florianópolis. The rough floods, gales, hail and droughts are frequent in the West. In Itajaí's Valley and Great Florianópolis the predominant disasters are the floods and the mass movements. It is reminded that the mass movements, such as landslides, mudflows, debris avalanche and rotational slumps, has the water of the rains as its main causing agent.

According to research of Hermann *et AL* (2004), between 1980 and 2003, the cities of Santa Catarina that presented the highest number of mass movement records were: Blumenau, Florianópolis, Brusque, Joaçaba, São José, Canoinhas, Gaspar, Ituporanga, Joinville, Rio do Campo and Angelina, mostly located on Sea Mountain Range, on Santa Catarina's East Mountain Range and on General Mountain Range.

The effects of the action of natural agents as the climate and the relief, are still aspects of great influence on the roads of the state. It could be felt during the rains of November 2008, which affected more intensely the central part, middle north and northeast of Santa Catarina. Several federal, state and city roads had their structure damaged. Among them, fundamental highways for population's moving and for the outflow of production, such as BR-101, BR-470, BR-282 and BR 280, which created serious trouble for the fulfillment of the basic functions and brought gigantic losses for the economy of Santa Catarina and Brazil.

Stretches of BR-101 and the secondary roads (as well as part of the state and city network) that go through the lands of crystalline bedrock have significant instability once gneiss, migmatite and filito that compose the geological unit, dated of the pre-Cambrian age, present

high level of decomposition resulting in thick blankets of alteration that, combined with factors such as constant rain and slope areas, determine terrains liable to mass movements. As Ab'Saber writes:

> The domain of "seas and hills" has been revealed, in relation to the anthropic actions, as the most complex and difficult physical, ecological and landscape environment in the country. […] it has been very difficult and expensive the opening, unfolding and conservation of new highways in the middle of the hills. It is also the area subject to the strongest erosion processes and collective movements of soil all around the Brazilian territory. (Ab'Saber, 2003, p.17)

The highway stretches that pass through these terrains of the coastline slope of Santa Catarina present intense traffic of passenger carrying vehicles and cargo trucks. They make the connection of the plateau with the coastline; interconnect several industrial centers of the Atlantic Valleys and to the ports and enable the tourism (mainly as the way of access to the beach resorts in Santa Catarina. Besides that, they connect the south, including MERCOSUL, with the rest of the country.

Due to the climatic vulnerability in Santa Catarina, the execution of new works on the roads and railroads demand thorough studies of the natural dynamics of the terrain and high amount of investments. They are needed for preventing the consequences of the recurrent natural catastrophes from happening. This way, it is possible to search measures of resilience to these specificities imposed by the natural picture, in order to ensure the well employment of scarce public resources and, above all, guarantee the safe circulation under any weather condition.

REFERENCES

Ab´Saber, Aziz (2003). Os domínios de natureza no Brasil: potencialidades paisagísticas. São Paulo: Ateliê Editorial.

A Notícia (2010). Searched on January, 2010 at http://www1.an.com.br/2002/jan/fotos/11cap02.jpg.

CPRM (2010). CPRM. Serviço Geológico do Brasil. Searched on January, 2010 at http://www.cprm.gov.br/.

Defesa Civil de Santa Catarina (2010). Searched on January, 2010 at http://www.defesacivil.sc.gov.br.

Guerra, A. J.T.; CUNHA, S.B.da (org) (1996). Geomorfologia e meio ambiente. Rio de Janeiro: Bertrand Brasil.

Herrmann, M. L. P. (2001). Levantamento dos Desastres Naturais Causados pelas Adversidades Climáticas no Estado de Santa Catarina no Período 1980 a 2000. Florianópolis: IOESC.

Herrmann, M. L. P.; Pellerin, J. R. G. M.; Saito, S. M. (2004). Análise das ocorrências de escorregamentos no Estado de Santa Catarina com base nos formulários de avaliação de danos da Defesa Civil – 1980 a 2003. In: Anais Iº SIBRADEN-Simpósio Brasileiro de Desastres Naturais. Florianópolis: GEDN/UFSC (CD-ROM).

Herrmann, M. L. de P. (Org.). Atlas de Desastres Naturais de Santa Catarina. 1º. ed. Florianópolis-SC: CopyLlaser Gráfica Digital, 2007.

Jochen, Toni (org); Werner, Antônio Carlos (2004). Caminhos da integração catarinense – do caminho das tropas à rodovia BR 282. Florianópolis: Edição do Autor.

Lago, Paulo Fernando (2000). Santa Catarina: a transformação dos espaços geográficos. Florianópolis: Verde água Produções Culturais.

Mamigonian, Armen (1958). O Habitat. In: Santa Catarina. DEGC. Atlas Geográfico de Santa Catarina. Florianópolis: DEGC/IBGE-CNG, 1958.

Mamigonian, Armen (1966). Vida regional em Santa Catarina. Orientação. São Paulo: USP/IG.

Mamigonian, Armen (1986). Indústria. In: Santa Catarina. GAPLAN. Atlas de Santa Catarina. Rio de Janeiro: Aerofoto Cruzeiro.

Mamigonian, Armen (2005). O Pensamento de Ignacio Rangel e a Questão Nacional Hoje. In: Estudos de geografia econômica e de história do pensamento geográfico. Tese (Livre Docência). São Paulo: FFLCH/USP.

Marcelino, E. V. ; Nunes, L. H. ; Kobiyama, M. (2006). Mapeamento de risco de desastre naturais do Estado de Santa Catarina. Caminhos de Geografia, Uberlândia,v.8, n. 17.

Mensagem do governador Vidal José de Oliveira Ramos (1912). Disponível no Arquivo Público do Estado de Santa Catarina – Florianópolis (SC).

Mensagem do governador Nereu de Oliveira Ramos (1936). Disponível no Arquivo Público do Estado de Santa Catarina – Florianópolis (SC).

Mensagem do governador Celso Ramos (1961). Disponível no Arquivo Público do Estado de Santa Catarina – Florianópolis (SC).

Mensagem do governador Esperidião Amin (1986). Disponível no Arquivo Público do Estado de Santa Catarina – Florianópolis (SC).

Monteiro, Carlos Augusto (1958). O Homem. In: SANTA CATARINA. Atlas Geográfico de Santa Catarina. Florianópolis: DEGC/IBGE-CNG.

Peluso Júnior, Victor A. (1952). O relêvo do Estado de Santa. Catarina. Publicação, n.3, Série 1, Florianópolis: Departamento Estadual de Geografia e Cartografia.

Peluso Júnior, Victor A. (1991). Aspectos geográficos de Santa Catarina. Florianópolis: Fundação Catarinense de Cultura/EDUFSC.

OHL Brasil (2009). Searched on January, 2009 at http://www.ohlbrasil.com.br.

Rangel, Ignácio (2005). Obras reunidas. Rio de Janeiro: Contraponto.

Relatório do Governador Abdon Baptista. Florianópolis (1906). Disponível no Arquivo Público do Estado de Santa Catarina – Florianópolis (SC).

Rocha, Isa de Oliveira ; Barbosa, Aurora Maria Putton ; Cabral, Elisa (2009). Notas sobre a infra-estrutura de transportes terrestres - rodoviário e ferroviário - de Santa Catarina (Brasil). In: Anais do 12 Encuentro de Geógrafos de América Latina - Caminando en una América Latina en Tranformacion. Montevideo: EGAL.

Santa Catarina (2009). Secretaria de Estado de Infra-estrutura de Santa catarina (SIE/SC). Searched on January, 2009 at http://www.sie.sc.gov.br/sie/competencias/ ferroviario.

Santa Catarina (2010). Secretaria de Estado do Planejamento de Santa Catarina (SPG/SC). Conhecendo Santa Catarina. Searched on January, 2010 at http://www.spg.sc.gov.br/cartografia/arquivos/ atlas/CAP_1_VERSAO_13_B.pdf.

Silva, Osmar Romão da (1941). Rotas pioneiras de Santa Catarina. IBGE: Revista Brasileira de Geografia. Rio de Janeiro: IBGE, Ano III, n. 4, 1941.

Teixeira, Eloísa de Carvalho (1968). Circulação. In: Geografia do Brasil: Grande Região Sul. Volume IV. Tomo II. Rio de Janeiro: IBGE.

Vieira, M. G. E. D.; Pereira, R. M. F. A. (1997). Formações sócio-espaciais catarinenses: notas preliminares. Anais do Congresso de História e Geografia de Santa Catarina. Florianópolis: IHGSC/CAPES/MEC.