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Typology of lotic environments by top down approach, Minas Gerais, Brazil

Melo, M.C.¹, Castro, P.T.A.², Freitas, M.D.F.P.P.³, Cordeiro, P.F.⁴, Ferreira, H.L.M.⁵

¹Instituto SENAI de Tecnologia em Meio Ambiente - SENAI FIEMG, email:marcia.melo@fiemg.com.br

²Universidade Federal de Ouro Preto, Escola de Minas, email:ptacastro@ig.com.br

³Instituto SENAI de Tecnologia em Meio Ambiente - SENAI FIEMG, email:mdfreitas@fiemg.com.br

⁴Instituto SENAI de Tecnologia em Meio Ambiente - SENAI FIEMG, email:pcordeiro@fiemg.com.br

⁵Instituto SENAI de Tecnologia em Meio Ambiente - SENAI FIEMG, email:hlmeneses@fiemg.com.br

Abstract

This paper presents the advances in typology lotic environments of Minas Gerais State, Brazil. From the regional scale, in its aquatic ecoregions, the variables considered were geology, by grouping of rocks with similar response to the weathering, and altitude, by the relief grouped into altimetry classes. The interaction of the layers resulted in 21 types represented in a map of typology of rivers in the State.

Keywords: aquatic ecoregion, typology of river, river environment

Introduction, scope and main objectives

From the beginning of this century, in order to meet the new guidelines of water management in Europe (the Water Framework Directive - WFD, 2000/60 / EC) the countries of the European Union began a new chapter in the assessment and monitoring of water resources, incorporating a broader view focused on the ecological quality classification of the aquatic environment (AQEM 2002).

This classification is guided by typology models of the aquatic environment based on interdisciplinary technological procedures grounded in the knowledge of abiotic and biotic particularities of the natural state (Ferreira and Castro 2005a, 2005b; Castro *et al.* 2005) taking as its starting point the aquatic ecoregions, which define the ecological homogeneity of aquatic landscapes (Sommerhäuser *et al.* 2011).

The classification consists in grouping of water bodies with relevant geographical and hydrological characteristics relatively homogeneous, in order to determine the ecological conditions, to establish the terms of reference and to compare ecological status classifications between groups with similar characteristics (INAG 2008).

In the search for suitable alternatives to know the state of preservation of water bodies, the European Union has adopted as evaluation criterion the typology of water bodies as part of a strategy to identify the alteration levels of a lotic, dammed lotic or lentic environment or even the water from watershed, a canal or a river segment.

This typology is made by the interaction between top down approaches (large scale and mesoscale) and bottom up (detail scale). In large scale, it considered variables as geology and altitude and in mesoscale hydrogeomorphologic variables, as thalweg slope, channel pattern and type of the

valley, which are validated by searching abiotic and biotic components, in detail scale, such as ecohydromorphology, chemical characteristics of water and sediments and biological community structure. The interaction of scales provides data and more complete information to support the proposition and implementation of management actions and restoration of aquatic environments. Based on the assumptions of the WFD – EC, this study aims to present advances in typology of water bodies in the state of Minas Gerais, Brazil, in top down approaches. This typology has statewide and aims to contribute to the improvement of methodologies that support the management of aquatic ecosystems and advances in compliance with the DN COPAM / CERH-MG nº001 / 2008.

Methodology/approach

The delimitation of aquatic ecoregions in Minas Gerais was based on the division established by Abell *et al.* (2008), adapted to the Atlantic Forest ecoregion which was divided into two areas (south and east) and on Resolution CNRH No.32, 2003 (National Hydrographic Regions). It was used digital files of Units Planning and Water Resources Management (UPGRH) of the state, scale 1: 1,000,000, available at IGAM (2009).

The typology of water bodies in regional scale covered the large-scale aquatic ecoregions defined for Minas Gerais considering the variables geology and altitude, descriptors of the System A (DQA 2000).

The lithological groups were defined from the source map CPRM/COMIG (2003) scale 1:1,000,000 and was used shapes files available at CPRM (2007).

The typology of water bodies based on geological synthesis of rock types that behave in a similar way to the surface processes, such as erosion, weathering and leaching that work in tropical climate. The rocks of the same class have in common the mineralogical composition of the sediments transported as suspension load and as bedload (acting as a substrate for aquatic organisms). Similarly, the ions in solution, result of leaching of the rocks are another lithological grouping criterion.

The altimetric classes were defined based on digital elevation model (DEM) of digital data from the site of EMBRAPA (2013), using ArcGIS 10.0 (TM) software.

The integration of geology information plans and altimetry one produced a synthesis map, whose analysis of the geographical representation resulted in the definition of altimetric classes: <500m, 500m and 500 to > 800m altitude (Fig. 1).

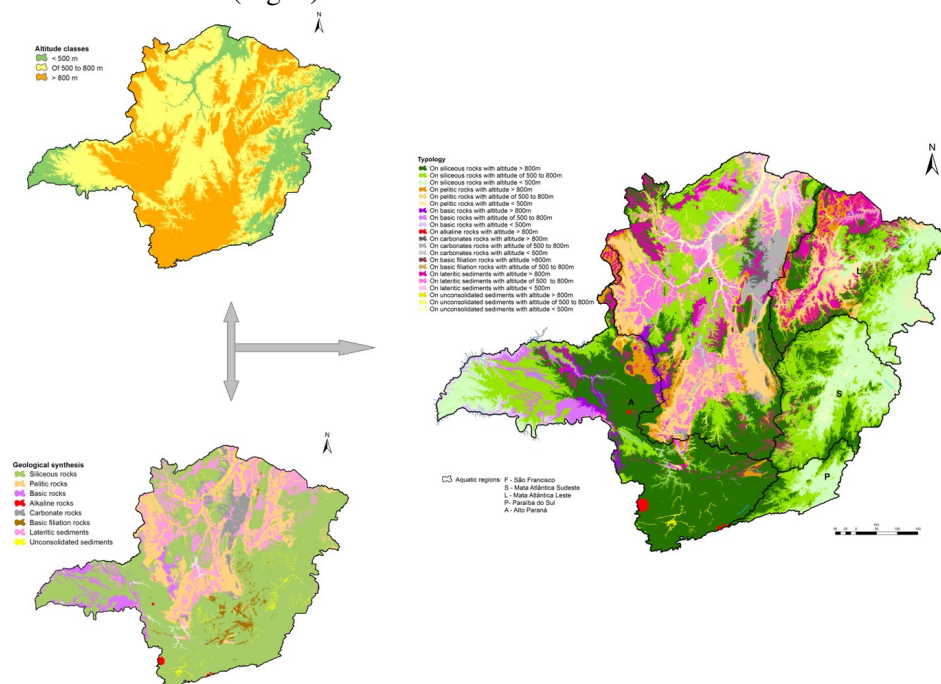


Fig.1: Interaction between the layers geology and altimetry that generate the type of terrains in the state of Minas Gerais, Brazil.

Based on System A, the attributes of this integration were incorporated into the river system of the State, provided by the IBGE (2012), scale 1: 1,000,000, generating a distribution map of types of water bodies identified in the state of Minas Gerais.

The use of a combination of hydrogeomorphologic variables slope, channel pattern and type of the valley, as permitted by System B of the EU Water Framework Directive (DQA 2000) results in the occurrence of 48 possible lotic types, in large scale.

Results

For the five aquatic ecoregions defined in Minas Gerais it have been identified, in large scale, 21 of types of terrains, in respect of the lithological group and altimetry.

A wide range of lotic types (18 types) drains the ecoregion São Francisco and Alto Paraná, in contrast to the Paraíba do Sul ecoregion with less representation (7 types). Most types drains of siliceous rocks and in all altitudinal. In second place are the types that draining on basic affiliation rocks and in unconsolidated sediments, both in 500m up to 800m altitude class. The types of alkaline rocks are restricted to more than 800m altitude class in the ecoregion Paraíba do Sul and Paraná. The lotic types of carbonate rocks are restricted to ecoregion São Francisco and Alto Paraná (Qd. 1).

Qd 1: Ocorrence of the types of terrains identified in Minas Gerais, Brazil, based on abiotic variables, per aquatic ecoregions

Types of terrains	Aquatic ecoregions (*)				
	São Francisco (F)	Mata Atlântica		Paraíba do Sul (P)	Alto Paraná (A)
		Sudeste (S)	Leste (L)		
On siliceous rocks with altitude > de 800m					
On siliceous rocks with altitude of 500 to 800m					
On siliceous rocks with altitude < 500m					
On pelitic rocks with altitude > 800m					
On pelitic rocks with altitude of 500 to 800m					
On pelitic rocks with altitude < 500m					
On basic rocks with altitude > 800m					
On basic rocks with altitude of 500 to 800m					
On basic rocks with altitude < 500m					
On alkaline rocks with altitude > 800m					
On carbonates rocks with altitude > 800m					
On carbonates rocks with altitude of 500 to 800m					
On carbonates rocks with altitude < 500 m					
On basic filiation rocks with altitude > 800m					
On basic filiation rocks with altitude of 500 to 800m					
On lateritic sediments with altitude > 800m					
On lateritic sediments with altitude of 500 to 800m					
On lateritic sediments with altitude < 500m					
On unconsolidated sediments with altitude > 800m					
On unconsolidated sediments with altitude of 500 to 800m					
On unconsolidated sediments with altitude < 500m					
Number of types per ecoregion in relation to the overall total (21 = 100%)	18 (85,7%)	13 (61,9%)	14 (66,6%)	7 (33,4%)	18 (85,7%)

(*) According classification of Abell *et al.* (2008)

The map of linear representation (river system) of river types showed on Fig. 2, is the result of abiotic analysis for the typology of water bodies on a large scale.

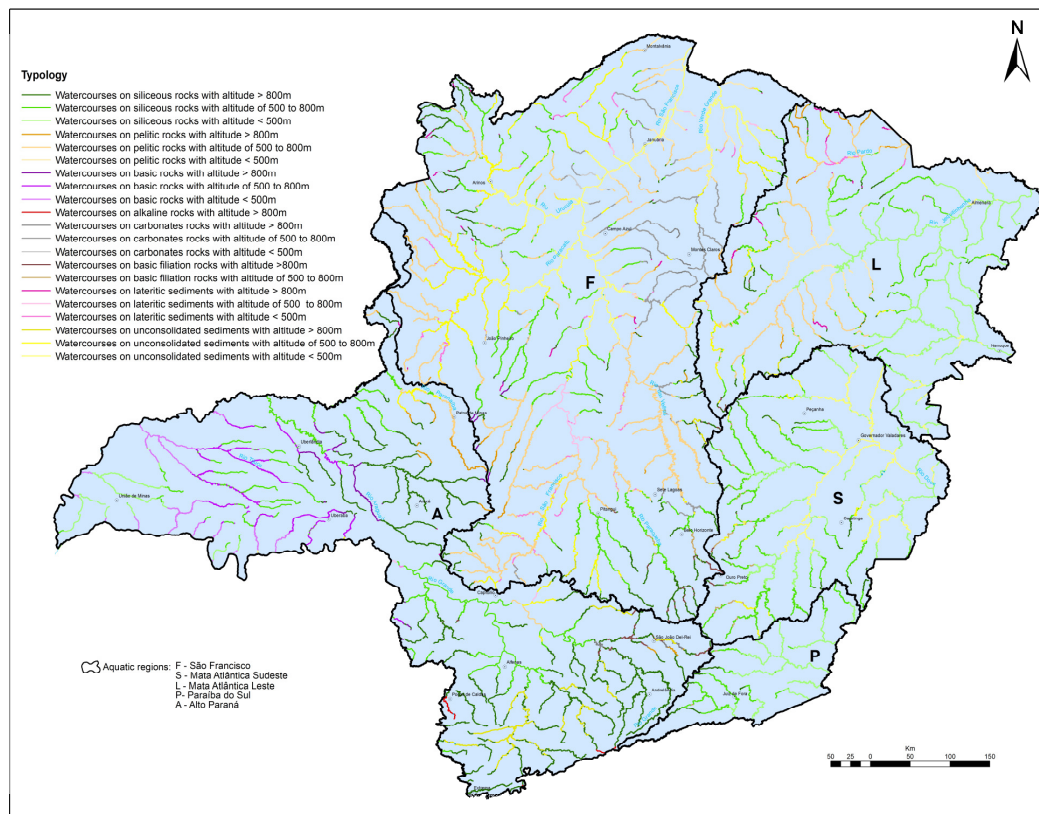


Fig. 2: Distribution of types of water bodies identified in the state of Minas Gerais, Brazil, based on lithologic group and class altimetric

Of the 21 types identified in the Minas Gerais territory more than 50% drain on siliceous rocks, and occur in all aquatic ecoregions especially in the range of 500 to 800m above sea level. They represent 57.25% in extension of the state drainage network. Fifteen types represent less than 5% of the total length of the water network (Fig. 3 and 4).

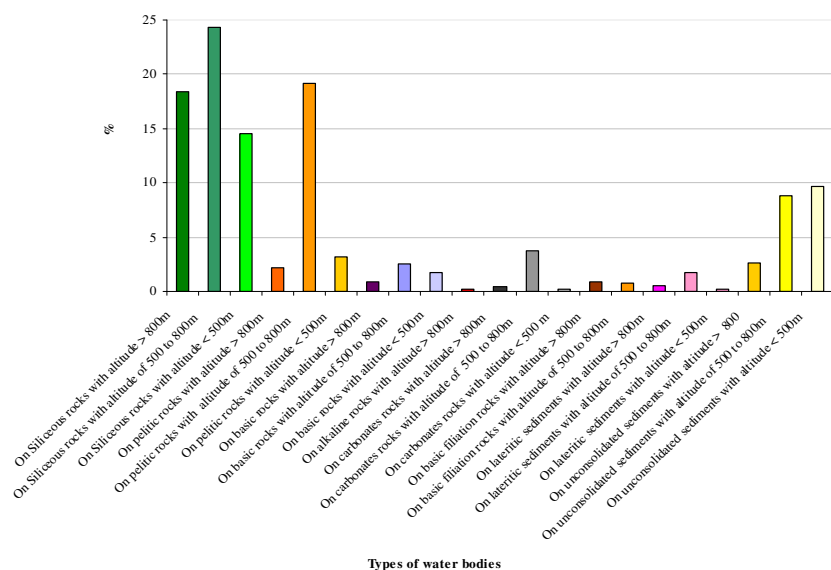


Fig 3: Percentage of the types of water bodies in Minas Gerais, Brazil, based on lithologic group and altimetric class

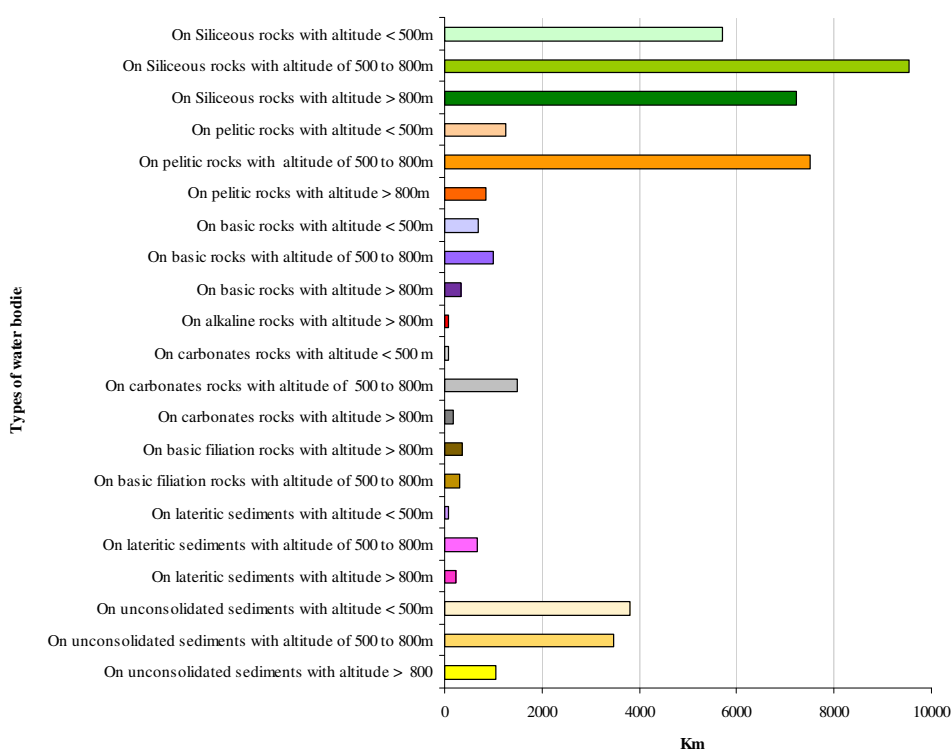


Fig 4: Extension (km) of the types of water bodies identified in Minas Gerais, Brazil, based on lithologic group and altimetric class

Discussion

The methodology in development showed its application to classification models of aquatic environments by group bodies of water with geographical and hydrological characteristics that are relatively homogeneous. Adjustments were necessary due to availability and limitations of the database and cartography, as well as the specificity of the state of Minas Gerais, in morphoclimatic terms.

Countries such as Germany (with 3 ecoregions and 25 types), Portugal (with 1 ecoregion and 15 types), and Chile (with 5 ecoregions and 35 types) used the methods available in the DQA (System A and B) for typology. The use of the same method for the state of Minas Gerais recognize 21 types in five aquatic ecoregions. In the European countries, the types of water bodies were identified by different variables and validated by biotic factors. The DQA eases the use of the variables of the system B, by understanding the ecological heterogeneity among countries.

The Identification of the types adopted for the state of Minas Gerais used System A variables, except the drainage area that is excluded for not contributing to the identification of regional standards. It should be noted that Germany, Chile and Portugal also initially adopted the system A, deleting some variables and later adding System B variables by using statistical analyzes. These changes are done because of the peculiarities of each country as well as the availability of data in compatible scale.

Conclusions/outlook

The classification of water bodies according to abiotic factors is the first step towards ecological assessment of aquatic environments, based on knowledge of abiotic and biotic specifics of its natural state. It shows the physical structure on which the biological communities develop to validate this classification. The study, in development, expands the understanding of the processes that affect and influence the structure and functional dynamics of freshwater ecosystems and contribute to the improvement of methodologies applicable to the monitoring, management and restoration of these environments.

For Minas Gerais were defined 21 types. It is possible to add 48 other combinations when considering the hydrogeomorphological variables.

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