Databases, GPS and Coordinates Systems [1]

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A georeferenced spatial database is the vertebral column of a Geographic Information System. The information contained in it needs to be consistent. For example: when manipulating a kneaded old map we may mistrust if it is updated and possibly its origin. The same, however, does not happen when we looked at an image generated on the screen of a computer. The allure that the technology exerts, almost instinctively takes to accept the information as being correct. However, in the background of what is shown on the screen, a database exists, that can even be the same used in the confection of the old map.

The construction or maintenance of a database can be made from the compilation of information derived from other databases, such as the digitalization of a map, or through new surveys, situation where GPS technology has been increasingly used. The GPS fits as a glove in the construction and maintenance of databases, generally associated to a Geographic Information System. The GPS informs the three-dimensional position of the space data and the time of occurrence of the interest event.

Much attention must be given two problems related to the use of GPS, associated to the databases. The first one refers to the use of coordinate system; the second on to the different precisions that GPS supplies. In this article, we focus on the issue of coordinate systems.

The Global positioning system uses a geocentric coordinate system: *the World Geodetic System* 1984 (WGS-84). The word "geocentric" means that the origin of the coordinate system is locates at the center of mass of the Earth. The WGS-84 is, for all practical aspects, equal to the South American Geocentric Reference System (SIRGAS). This means that coordinates expressed in SIRGAS are identical to the ones expressed in WGS-84. The access to SIRGAS is possible through the use of observations collected by the Brazilian Network of Continuous Monitoring of GPS (RBMC). This network has been in operation since December of 1996. It has 14 stations distributed along the Brazilian territory, in continuous operation. The Brazilian Institute of Geography and Statistics (IBGE) maintains and operates the network. IBGE makes available, to interested parties, the observations collected by the RBMC. All RBMC stations are part of SIRGAS.

However, mapping in Brazil uses, since the 1970s, the *South American Datum of* 1969 (SAD-69) as coordinate system. Among the many differences between these tow coordinate systems, we would like to stress the fact that, in contrast of the WGS-84, the SAD-69 is not a geocentric system. In other words, the origins of the two systems are displaced in space, being approximately 78 meters apart from each other.

The consequence of this fact is tremendous: the positions supplied by GPS receivers do not speak directly with maps!

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[1] English version of the paper *Banco de dados, GPS e sistema de coordenadas*, published in the Brazilian magazine *InfoGeo*, Year 2, No. 5, January / February, pp. 27-28, 1999.

There is, still, an aggravating problem: in Brazil, another coordinate system was used before the adoption of the SAD-69. This system is known as *Córrego Alegre*. Likewise the SAD-69, it is not geocentric. There still exist many cartographic documents built using *Córrego Alegre* coordinate system. And many agencies still use *Córrego Alegre* today.

How does this fact affect the use of GPS in Brazil? The use of GPS in Brazil requires the use of *transformation parameters* that relate WGS-84 and Sad-69. Mostly in the activities that use maps, or that result in visualization of the spatial information, all of them depending on databases. The parameters of transformation to be used must be those supplied by the IBGE.

The perception that distinct coordinate systems co-exist must lead to a cautious attitude, namely, to always question what is the system to which the coordinates are referring. This must be adopted as general rule. In all lists of coordinates, as well as in all maps, the used coordinate system must be indicated. This rule also applies to all databases, which must have a field that makes possible that the information system distinguishes between existing the coordinates systems (assuming that the information system is capable to relate them, through the appropriate parameters of transformation). Ideally, it is built and maintained based upon the same coordinate system (and that everyone know which are). Otherwise, the purpose of a Geographic Information System, which is to allow decisions to be taken by correlation of information, will not be reached.

As example on the seriousness of the problem, let us consider Figure 1. The position of point RN-18 is represented on an urban map, in the scale of 1:6,000, constructed in the SAD-69. This point lies at the edges of an avenue, at the crossing with a railway. The representation of this point on the map reflects its actual location since the database for the construction of the map (in SAD-69) is coherent with its coordinates (also in SAD-69).

But what would happen if RN-18 coordinates were directly supplied by a GPS receiver or expressed in the *Córrego Alegre* system? In this in case, RN-18 would be represented in a wrong position. This fact is shown in the figure below. It can be clearly seen that RN-18 can be located in three different places, each one in a different coordinate system. This illustrates well what can happen if the database is inconsistent as far as the coordinate system used.

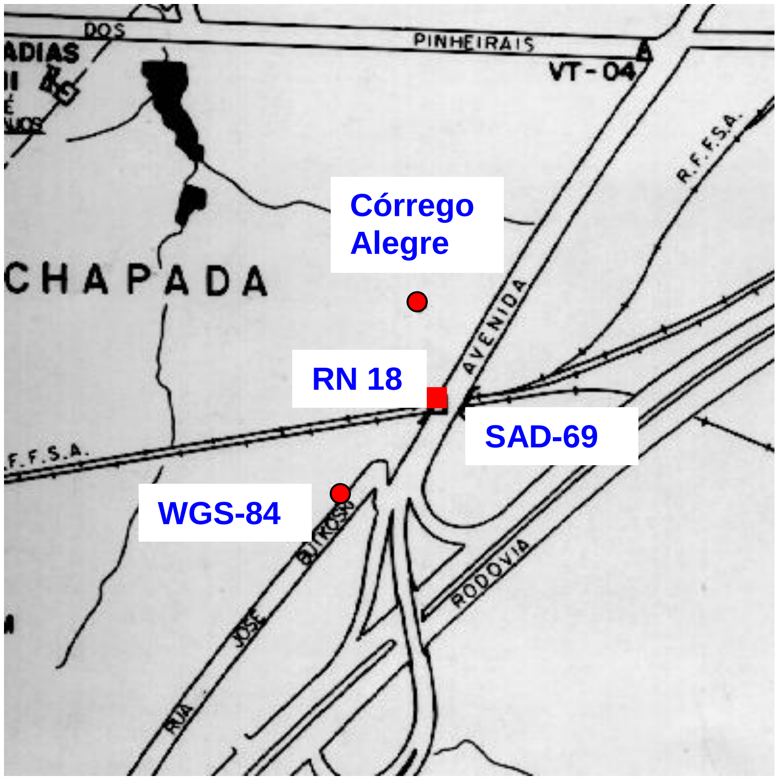

Figure 1 Impact of Disregarding the Different Coordinate Systems in Brazil.