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A DIGITAL VERSION OF HUECK'S VEGETATION MAP OF SOUTH AMERICA: 50 YEARS AFTER THE RELEASE OF HIS BOOK ON THE SUB-CONTINENT'S FORESTS

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RESUMEN

Kurt Hueck vivió diez años en América del Sur, donde estudió la vegetación del subcontinente. Su trabajo resultó en un libro sobre los bosques y en un mapa de la vegetación. Dado que la descripción de la leyenda del mapa tiene estrecha correspondencia con el contenido del libro, se tuvo la idea de generar una versión del mapa original compatible para los sistemas de información geográfica. Muchos estudios sobre la distribución de especies pueden beneficiarse de su uso para extraer criterios adicionales para el modelado o bien como un mapa de referencia para la interpretación de los modelos resultantes. Después de 50 años, la forma de dibujar mapas ha cambiado, pero el conocimiento contenido en mapas como el de Hueck es un valioso registro de un momento en el que la vegetación se encontraba más conservada.

RESUMO

Kurt Hueck viveu dez anos na América do Sul, onde estudou a vegetação do subcontinente. Seu trabalho resultou em um livro sobre as florestas bem como em um mapa sobre a vegetação. Como a descrição da legenda do mapa tem estreita correspondência com o conteúdo do livro, imaginou-se ser útil gerar uma versão do mapa original compatível para uso em sistemas de informação geográfica. Muitos estudos sobre a distribuição de espécies podem se beneficiar utilizando-o para extrair critérios adicionais para modelagem ou como um mapa de referência para interpretação dos modelos resultantes. Após 50 anos, a forma de desenhar mapas mudou, mas o conhecimento contido em mapas como o de Hueck é um registro valioso de uma época em que a vegetação estava mais conservada.

ABSTRACT

Kurt Hueck lived ten years in South America where he studied the vegetation of the sub-continent. His work resulted in a book of the forests as well as a wall map on the vegetation. Since the

description of the map legend has close correspondence to the book content, we thought it could be useful to have a GIS-compatible version of the original map. Many studies on species distribution can benefit from it as additional criteria for modeling, or as a reference map to interpret modeling results. After 50 years the way of drawing maps has changed, but the knowledge embedded in legacy maps like Hueck's one, is a valuable record of a less disturbed environment.

Keywords: phytogeography, vegetation mapping, legacy maps, geospatial data, GIS, cartography

INTRODUCTION

The advance of modeling techniques in biological sciences increased the interest on spatial environmental variables for use in GIS-Geographic Information Systems. Climate, elevation, land use and natural potential vegetation data are frequently employed. Regarding vegetation maps, there are some with global coverage, but they lack in detail if used on continental or sub-continental studies. For South America, Hueck's vegetation map is a frequent reference in phytogeographic and biogeographic studies, suggesting that a GIS-compatible version would be welcomed to the vegetation science community. We aim to report the release of such a product of Hueck's vegetation map of South America (original scale 1:8,000,000).

BACKGROUND

Prof. Dr. Kurt Hueck (1897-1965), a German botanist, lived and worked ten years in South America. First in Tucumán, Argentina (1949-1953), then in São Paulo, Brazil (1953-1956) and later in Mérida, Venezuela (1956-1959). During this time, he conducted several field expeditions in different regions of South America, and had the opportunity to share his knowledge with local scientists. He also got in contact with other foreigner contemporaries scientist which also were active in the continent. These field trips and personal contacts both helped him to conceive the book *Die Wälder Südamerikas - The forests of South America*, in 1966, exactly 50 years ago. Translation into Portuguese and Spanish were released in 1972 and 1978, respectively. It brings as first figure a simplified version of the *Vegetationskarte von Südamerika - Vegetation map of South America* (Hueck 1966, p.3). Despite the title encompasses only forests, the book also dedicates some chapters to vegetation types like woods, savannas, grasslands, and other.

Hueck dedicated more than 15 years of his life to synthesize the knowledge about South America's vegetation, and was conscious of the importance of his work. In his words, the book "is not only a theoretic scientific phytogeographic work, but a research of practical value" (Hueck, 1966; Foreword). In spite of being able to revise the originals, Hueck died in 1965, before the release of his book. His last working place was at the *Waldbau-Institut*, Munich. When Prof. Dr. Paul Seibert began to work at the same place in 1969 he received, among other working materials left by Hueck, a sketch of a wall map. Knowing that a larger vegetation map than the one enclosed in the book would be very useful to the scientific community, Paul Seibert took it upon himself the commitment to get it published. One of the difficulties he faced was to harmonize some of the legend entries of the map to the phytophysionomies described in the book. Furthermore, some new studies were published since the release of the book up to Seibert's work, but a thorough revision of the map would further delay its conclusion. So, the full map was finally published in its first edition in 1972, in scale 1:8,000,000 (68,5cm x 96,5cm), followed by an explanation booklet (Hueck & Seibert, 1972). A second edition was published later with a much richer bibliography (Hueck & Seibert, 1981).

The scale 1:8.000.000 seems to be small, but maps covering the entire sub-continent in such a thematic detail of vegetation types are quite rare. There are other vegetation maps for the region (e.g., Unesco, 1980), but none of them have a so rich description of legend categories as found in Hueck's book published before. Some South-American countries may have their own vegetation maps in even greater detail, but mosaicking them to build a unique map for the whole sub-continent is not an easy task. A previous effort to harmonize legends would be needed, due to different criteria adopted in each one.

PROCEDURES AND PRODUCT

A first challenge to generate a GIS-compatible coverage of Hueck's original map lies on the lack of information concerning parameters of the cartographic projection and the geodetic reference system used. Such metadata became usual after the 1990's, but were not before, especially with small scale thematic maps. Thus, we took the scanned map available at EuDASM-European Digital Archive of Soil Maps (EUSDAC, 2015) and tested different geo-registering methods, using as control points all of the 73 intersections of latitude and longitude lines printed on the map. The adjustment was checked with the RMSE and by overlaying a calculated graticule on each result. We concluded that a 5th degree polynomial function allowed to the best fit, with a RMSE-Root Mean Square Error of 3,100m (0.4 mm in scale 1:8,000,000) (Figure 1).

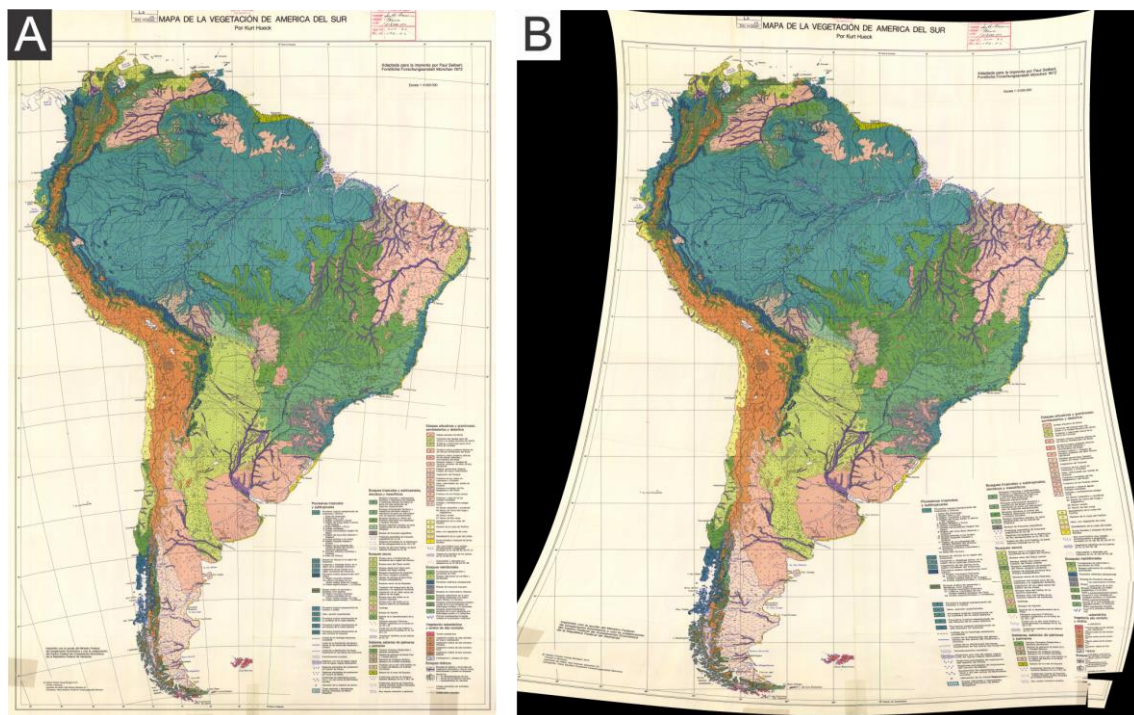


Figure 1: (A) Original vegetation map with unknown reference system and (B) same map after georeferencing to geodetic coordinates.

The georeferenced raster map was transformed from geodetic coordinates (non-projected) to the Lambert Conformal Conic projection, assuring a spatial resolution of 1,000m. As no datum information was available in the original, we assumed compatibility to WGS84 and did not perform datum transformation. In fact, South American datum differences become irrelevant given the small original map scale, as they are usually of tens of meters. The projected map was then used as backdrop for manually digitizing the boundaries of the vegetation polygons, aiming to follow cartographic standards to ensure the best possible geometry. A homogeneous display scale used was

at least 10-times greater than the original (1:800,000 or larger), and snap tolerance and vertex weed tolerance at least 10-times smaller than the presumed graphical error (500 m) of the printed map.

Once all the boundaries were digitized, the obtained vector layer was submitted to a topology checkout, and finally to the step of building the vegetation polygons. At last, the polygon layer was linked to an attribute table conceived to retain most of the original legend information. A set of fields was created to comprise the hierarchical structure of vegetation types, preserving both the original Spanish and German names, as well as the correspondent numeric code (Figure 2).

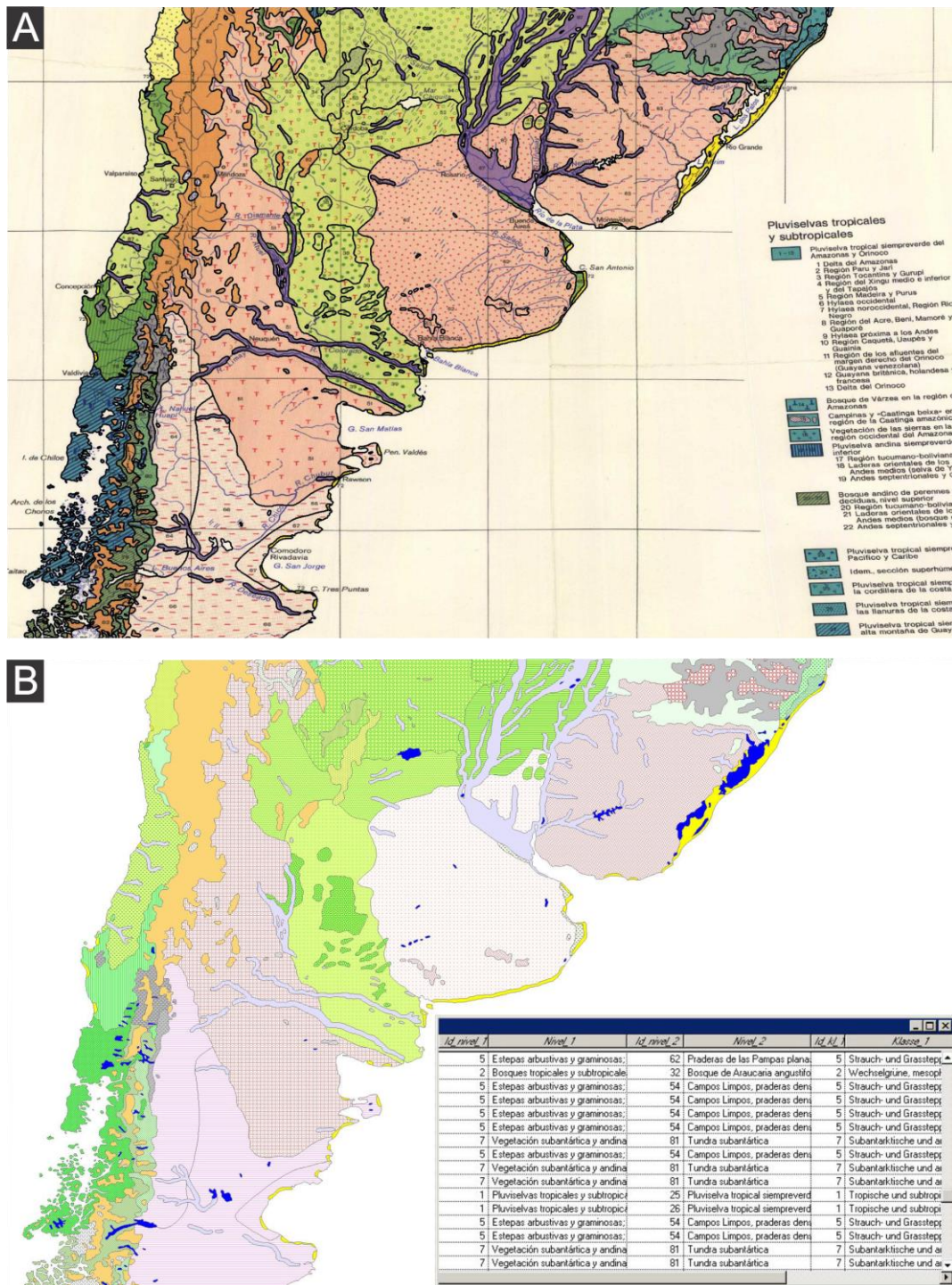


Figure 2: (A) Vectorization on vegetation map and (B) final shape file with attribute table containing the two levels of the map legend.

The final product is able to be used in a number of GIS-based analyses, like queries, grouping and landscape metrics. We expect the presented geospatial data will also be useful for many modeling purposes, both as input data as well as reference to compare results on a sub-continental basis. Furthermore, given the variety of web mapping tools and satellite imagery currently available, it has the potential to serve as a starting point to produce an updated version of South America's vegetation map by means of collaborative efforts of researchers from many countries.

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Supporting information

Appendix S1: [Vegetation map of South America by Hueck & Seibert \(1972\): vector coverage for use in GIS \(shape file, with description text\)](#)

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