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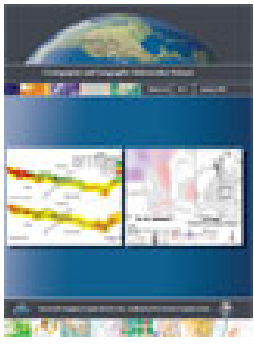
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## Waldo R. Tobler (1930–2018)



Waldo R. Tobler, Emeritus Professor of Geography at the University of California, Santa Barbara (UCSB), passed away on 20 February 2018, aged 88. His contributions to cartography and geography were numerous, and his career stretched over an extraordinary six decades that witnessed the technological transition in car-

tophography from a manual and mechanical craft to a digital and mathematical science. While best known in recent years for his famous Tobler's first law of Geography, a mere note in his 1970 paper on cartographic animation (Tobler, 1970), Tobler also made major contributions in map projections, cartograms, unclassed choropleth mapping, flow mapping, and in the mathematical basis of migration flows and properties of continuous fields. A major innovation was his portrayal of most digital cartographic operations as invertible or non-invertible transformations (Tobler, 1959). He has long been seen as the originator of Analytical Cartography as a field of study (Tobler, 1976, 2000), which he defined as a subdiscipline of cartography dealing with the theoretical and mathematical background behind cartography and the rules cartographers employ in the mapping process. Tobler noted that the mathematical and analytical parts of cartography remain independent of technology, and so apply to both paper and online maps and their digital databases.

Over the period 1956–2018, Tobler published 47 peer-reviewed journal papers, cited some 3200 times according to the Web of Science. The scope of this work – and the many unpublished papers, lecture slides, and other works that Tobler left behind – is captured by the first and last of the paper titles: from his first publication with B. Ingalls, *Recording map and monument information on IBM cards*, (Tobler & Ingalls, 1956) to his most recent, the brief “A new companion for Mercator,” which appeared in Volume 45, number 3 of this journal earlier this year (Tobler, 2018). Tobler's work places him as one of the leading minds of the first generation of digital cartographers. His 1988 Honorary Doctorate from the

University of Zurich named him as the “major analytical cartographer of the twentieth century.” He was among the first geographers elected to the U.S. National Academy of Sciences.

Tobler was born a dual US/Swiss citizen in Portland, Oregon, his father being a Swiss consular employee. After growing up in the US and throughout parts of Europe, he joined the U.S. Army in Europe in 1948, a service that was extended 4 years by the Korean War. During part of this time, he served as an interpreter and intelligence analyst interviewing WWII Austrian military staff who had been prisoners of war in Russia, and became familiar with German maps and air photos. On his return to the US in 1952, he enrolled first at the University of British Columbia, before moving to the University of Washington. At that time, Seattle was a center of the quantitative revolution in Geography, and many of his fellow graduate students (John Nystuen, Art Getis, William Bunge, Brian Berry, Duane Marble among others) and faculty (William Garrison, John Sherman, and a visiting Torsten Hägerstrand) became influential in sparking a new scientific and mathematical rigor for the discipline. He completed the MA in 1957 with a thesis on hypsometric colors on maps and joined the Systems Development Corporation, then splitting off from RAND, to work on “computer printed maps used in air defense simulation exercises.” Later, he worked at the Pierce County Planning Commission, and made the decision to return to Seattle for the PhD. This he earned in 1961 with a dissertation entitled “Map Transformations of Geographic Space,” which “spelled out for the first time the partial differential equations that govern the class of map projections known as anamorphoses (also known as cartograms)” (Tobler, 2002, p. 306).

In 1963, after a summer working with William Garrison, Tobler joined the faculty at the University of Michigan. Tobler was highly productive during the Michigan years, helping found the Michigan Interuniversity Community of Mathematical Geographers and its publication series, participating in studies for the National Academy of Sciences, and developing new classes, including Geography 482 Analytical Cartography (Hessler, 2015), a class I taught

while still a graduate student at Michigan in about 1981. While at Michigan he played a role when the Chicago AAG meeting in 1968 had to be moved on short notice to Ann Arbor. Tobler also translated Lambert's classic *Notes and Comments on the Composition of Terrestrial and Celestial Maps* (Tobler, 1972), and published a highly influential set of FORTRAN computer programs. Several papers dealing with map transformations, map projections, geographical filters, migration "winds," accessibility, and cellular geography date from this period. A sabbatical during 1974–1975 at the International Institute for Applied Systems Analysis in Vienna continued his direct contact with German, Swiss, Russian, and other European scholars.

In 1977, Tobler joined the new Department of Geography at the UCSB. This was much to my loss, because I had been accepted to the PhD program at Michigan in Fall 1977 and hoped to work with him. Nevertheless, I was delighted that he provided generous feedback on my dissertation research, and when he retired early in 1994 left open the position of cartographer at UCSB that I was able to fill. In Santa Barbara, Tobler found much common ground with David Simonett, Reginald Golledge, Jeff Dozier, Mike Goodchild, and others. While at UCSB, Tobler worked on building a high resolution global demographic gridded database, collaborated with Peter Gould over a global grid project (Gould & Tobler, 2003), and continued a lifelong interest in historical cartography, especially portolan charts, by touring many of the world's leading map libraries. His original interest in migration flows led to software for flow mapping, and his ongoing interest in the International Geographical Union and the International Cartographic Association led to much global travel, to Europe, China, South America, and beyond.

Overall, Tobler's lasting legacy has been to strengthen the mathematical foundations of analytical cartography, but also to retain a focus on using maps for practical problems. His grasp of other disciplines and languages strengthened this legacy. After his retirement, Tobler continued to publish, participate in Regional Science Association conferences and almost every Autocarto meeting, served on graduate committees at UCSB, and participated in campus events, lectures, and meetings. About once a week he would stop by my office to talk ideas – papers he had read (or published), topics of interest, and the topics of my classes that week. Through his website, and frequent correspondence by email with many people from artists to the ICA Map Projections Commission, few that knew him do not have a collection of homemade CDs with his latest conference presentation, an unpublished paper, or notes on a

new idea. By my count, he published 15 papers as author or coauthor in the journal *Cartography and Geographic Information Science*, and its predecessor, *The American Cartographer*. Many of these are cartographic classics, essential reading for graduate and undergraduate students alike. At the end of his life story "Ma Vie" (Tobler, 2002) he concludes that there are "still plenty of interesting problems that need my attention." It is time to pass these challenges on to the next generation, for the digital transition in cartography is now complete.

### Disclosure statement

No potential conflict of interest was reported by the author.

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