World maps in a time of crisis

Peter Vujakovic

Peter provides an overview of the relative merits and problems of different map projections.

In the year in which Greta Thunberg, the Swedish teenage 'climate change' activist, galvanised public opinion during her visit to the UK, the Extinction Rebellion movement brought parts of London to a standstill, and in which evidence of plastic waste was found at the bottom of the Mariana Trench, it is important to reflect on the global issues – economic and geopolitical, as well as environmental – that face us today, and how we address these as teachers of geography. One way we can do this is by providing our students with clear information that allows them to think critically and make informed choices. A key tool at our disposal must be maps and related information graphics.

Maps provide an immediate and effective visual stimulus to thinking and debate, but their form and function need to be taught and understood, because maps can also mislead, and very often do, as examples from educational publications to the news media show. E. Lynn Usery, Director of the US Geological Survey Centre of Excellence for Geospatial Information Science, has warned:

> *It has never been more important in the history of cartography … that people understand how maps work. With increasing globalisation, for example, world maps provide a key format for the transmission of information, but are often poorly used.* (Usery, 2018, p. 202)

A range of projections

Politicians and social commentators speak glibly of the 'existential crises' facing the world, often in very general and disquieting terms. Maps can help our students to make sense of these issues, but only if the maps we expose them to are effective. Sadly, many creators of world maps still employ incorrect or poorly chosen projections, often combined with unwarranted connotations due to the choice of colour (e.g. red implying 'danger') or melodramatic graphics. Projections are the systematic transformation of the globe to a flat surface, but no single map projection can be effective in all circumstances. All include some form of distortion, whether of area, distance, or the shape of continents. We must alert our students to the biases, deliberate or not, that poor choice of projection can convey – we need to teach them to understand *how maps work*. The point of this article is not, however, to provide practical advice on teaching projections (see below for some suggestions), but to encourage critical thinking concerning the maps we expose students to, or ask them to use in their own work. Incidentally, it is now a decade and a half since my plea for *diversity* in the use of world maps in education was published in *Teaching Geography* (Vujakovic, 2004), a plea which remains current. One of the enduring myths of cartography is that a certain type of world map can provide a 'one size fits all' answer for general educational purposes.

Some people have advocated what are known as 'compromise projections', involving the 'least bad' distortion of all key attributes (area, shape, scale). A classic example is the widely adopted Robinson projection, originally called the 'orthophanic' (right-appearing) projection, designed by Arthur H. Robinson in the 1960s (Snyder, 1993). The other popular option has been the use of one or other equal-area projection; these produce world maps that show continents and countries in their correct area relative to one another (while accepting other distortions, especially shape). Equal-area is a property of maps referred to as 'equivalence'. These projections are often contrasted with the classic Mercator world projection, which exaggerates area in the high latitudes, such that Greenland appears larger than the whole of South America, while actually being some eight times smaller. It is due to this exaggeration that the use of Mercator has been condemned as 'imperialist'; for example, it over-emphasises northern Europe compared to Africa and southern Asia. However, as Snyder (1993) reminded us, 'Mercator's chief purpose in developing the [1569] projection was navigational' (p. 45). Its use has significantly declined as a world base map for educational use, although it still appears in other contexts.

The idea that a single 'correct' map exists is a legacy of the so-called 'Peters Phenomenon'. The German historian Arno Peters introduced his equal-area projection and map to the world in the late 1960s, and by the 1980s the map appeared in the influential North-South ('Brandt') report on world development (Brandt, 1980). It was subsequently adopted widely by development educationalists and NGOs, as well as UNESCO. His map *does* show the continents and countries in their true area, but is not the first to do that, nor the best in terms of preservation of shape. Many in the cartographic community slated Peters, and claimed his projection was simply a reintroduction of that published in 1885 by the Rev. James Gall (hence the use of the title 'Gall-Peters' among cartographers). The backlash was as much a reaction to Peters, who as a non-professional 'outsider' had managed to influence map users where the cartographic community had failed make any real impact. Sadly, the cartographer's job was not helped by poor use of map projections in a wide range of popular and academic publications (Vujakovic, 2002).

Equal area projections

The Mercator projection was Arno Peters' *bête noire*. It was the projection placed alongside the Peters in a range of publications which sought to address bias in mapping. In the mid-1980s, against the grain, when many UK development education organisations and charities were adopting the Peters projection, I convinced the World Development Movement (WDM; a UK national NGO lobbying on development issues)

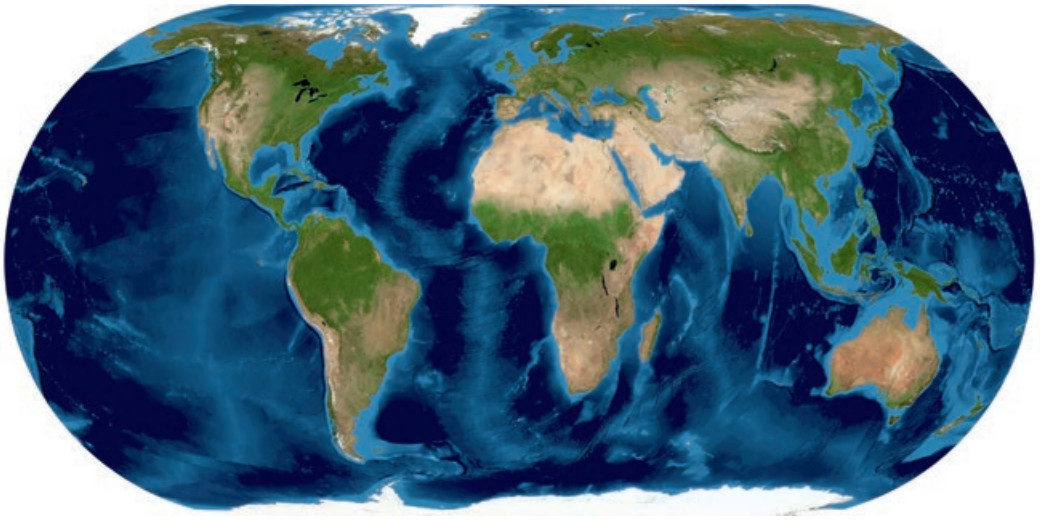

Figure 1: Complete Earth view from space. High resolution world map illustration in Eckert IV projection. Data source NASA. **Photo:** © Shutterstock/ Volodymyr Nikulishyn.

to adopt Eckert IV (another equal-area projection – Figure 1) as the base for most of their thematic maps. WDM received some angry responses to this, as other organisations thought that if we were not using Peters, we must be using Mercator. The serious lack of basic cartographic understanding was obvious. It exposed the fact that individuals and organisations, while understanding that *maps matter*, did not understand the options available to them, but tended to accept the 'politically correct' map based on who shouted the loudest.

Creating and popularising an equal-area projection to compete with Peters appears to have become a cartographic 'holy grail'. The US company ODT Maps, which has done much to publicise and market the Peters map, produced a similar map, their Hobo Dyer Projection (2002), which they claimed removed some of the exaggeration (elongation of Africa, for example) inherent in Peters, but produced compression at the poles. The map achieved a high profile, being adopted by, for example, US President Jimmy Carter, and was used at his Nobel Peace Prize ceremony in 2002. More recently, a team of cartographers, Bojan Šavrič, Tom Patterson and Bernhard Jenny (2018), has launched a new equal-area projection, 'Equal Earth':

> *The Equal Earth map projection is a new equal-area pseudocylindrical projection for world maps. It is inspired by the widely used Robinson projection, but unlike the Robinson projection, retains the relative size of areas … Continental outlines are shown in a visually pleasing and balanced way.* (p. 454)

In visual terms, however, Equal Earth varies little from other projections, especially Eckert IV. In the end, the choice of an equal-area projection is largely a matter of taste and message (see for example, the Atlantis projection (Vujakovic, 2004), a novel equal-area projection that focuses on the Atlantic Ocean and shows Antarctica in roughly the correct shape). Equal-area maps are clearly the sensible default, as they *generally* do no harm to most data sets, and ensure that environmental issues which are area-dependent, such as forest loss, land degradation or desertification, are displayed effectively. Whether they are 'fairer' to the peoples of the world is more open to debate; I have discussed this in some detail in *Teaching Geography* (Vujakovic, 2004). That article was itself a response to David Wright's (2003) 'Questioning world maps' in which he argued for the use of equal-area maps *as the norm in teaching*, and in which I argue for using cartograms and 'polyhedral maps' as stimulating alternatives. If fairness to the world's people is a basis for choice of world map, then a population cartogram (map or diagram?) would be a good alternative, with other thematic data superimposed as appropriate. Many readers will be familiar with the Worldmapper project and its range of interesting cartograms; these provide an excellent resource to stimulate debate in class – for example, their maps of carbon dioxide emissions shows China as a major global contributor, but begs the question 'Whose pollution is this?'; is it in fact western consumers exporting their dirty industries?

Avoiding pitfalls

In what is left of this article I enumerate some pitfalls that students should be aware of. The first is the issue of centring and orientation. This is more insidious than the simple choice of projection. Despite the efforts of educationalists and others, most world maps that students in the UK are exposed to are 'Eurocentric', i.e. orientated with north to the top and Europe placed centrally. Even Stuart McArthur's well-known 'Universal Corrective Map of the World' (launched on Australia Day in 1979), which placed Australia at top centre, has scarcely dented the Eurocentric bias. This bias should be a cause for concern as it certainly does create an unwarranted sense of superiority. It also means that when a Pacific-centred map might be more practical use, it is often not used. It is interesting to note that neither Arno Peters nor Worldmapper seek to challenge the dominant orientation or centring of world maps. Additionally the Worldmapper base map (un-named), described as 'equirectangular', clearly exaggerates the size of Greenland compared to south America and is not an equal-area map. When I interviewed Peters in the 1980s, he felt that a change in orientation, on top of his already unfamiliar map, would be too much of a challenge for map readers. One of the failings of so many 'experts' is the lack of trust in students or the wider public to be able to cope with change.

Another key issue that is often misunderstood is scale related to distances, and the fact that this is not constant across the whole map, but only for certain aspects. For example, the linear scale of a Mercator map increases with latitude and is only constant along a line of latitude; this is the reason it distorts (enlarges) the size of continents further from the equator. Beyond 70° north or south the Mercator projection is practically useless, because the linear scale becomes infinitely large as the poles are reached, making it impossible to produce a Mercator map of the whole world! Where scale becomes critical, however, is for specific issues such as mapping the geopolitical threat posed by intercontinental missiles. The UK news media, for instance, has tended to adopt standard rectangular world map projections for most purposes, including displaying missile ranges (Figure 2). On such maps it appears that the most direct missile route from, say, North Korea to the US mainland would track the line of latitude 40°N, while in fact the direct route would follow a Great Circle across the Aleutian Basin (between 50° and 60°N). These missile ranges can only be genuinely shown as concentric circles if based on an equidistant (polar style) projection centred on the launch site (Figure 3). The use of a standard equal-area map would be just as useless to show missile ranges as concentric circles (Vujakovic, 2018).

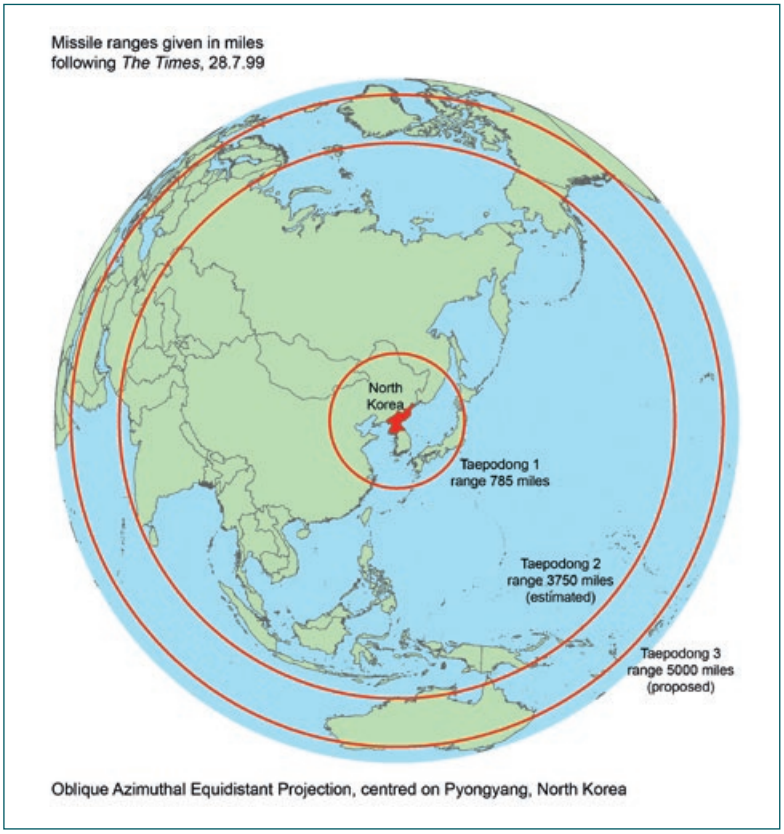

Figure 3: Map of missile ranges shown correctly as circles on an equidistant projection.

Further reading and resources

While I have made the point that this article is not designed to provide practical advice regarding map projections in learning and teaching, there are a number of resources that will be beneficial to those seeking materials to help develop their classroom activities or to explore world map projections in more detail. The most obvious class resource is the latest edition of Woods *et al.* (2019). While designed primarily for a US audience, their book is a clearly written introduction to mapping, with a strong focus on world maps. It provides a range of ideas that will help teachers engage students with maps and issues such as centrism and orientation, as well as exploring diversity in map projection as a positive issue rather than a source of confusion. The following quote sums up their approach to education:

> *What we have begun here is a process of 'unpacking' or 'decoding' maps. Such a process requires us to equip ourselves with analytical tools – tools that will help us see through maps to discern their motivating agendas. Without such tools we simply accept what maps tell us. Learning to ask the right questions can help to liberate our thinking. It can free us from bondage to other peoples' agendas. Why should we passively allow our minds to be taken over by someone else's image of the world?* (p. 36)

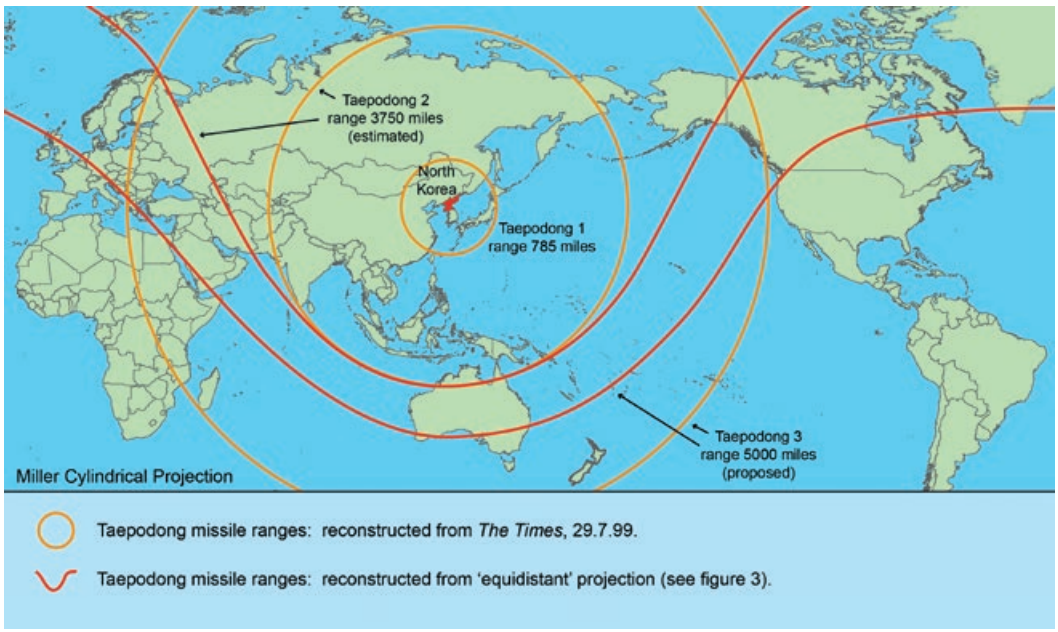

Figure 2: Map of missile ranges on rectangular world map, showing original 'circles' and corrected for true distance.

Another current resource is Oxfam's 'Mapping Our World' (designed for 8–14 year-olds), an entertaining and interactive update of their 1993 hard copy resource pack aimed at UK schools.

Other sources, for those who wish to explore world mapping in more detail, include John. P. Snyder's (1993) classic (and evocatively named) *Flattening the Earth: Two Thousand Years of Map Projections*, which provides a comprehensive overview of world mapping. Snyder has been my 'go to' text for two decades of studying maps in the news media. A recent important resource is Usery (2018); although as one of the editors of that text, I have to acknowledge that the exemplars were almost entirely Eurocentric. Another resource which provides useful information on appropriate choice of projection is ESRI's 'Projection toolset' website; as they point out:

> *… anyone who uses maps as analytic tools should know which projections distort which properties and to what extent. Briefly, conformal maps preserve shape; equal area, or equivalent, maps retain all areas at the same scale; equidistant maps maintain certain distances; and azimuthal, or true direction, maps express certain accurate directions.*

The site provides detailed information on a wide range of world map types, but once again, the graphic examples are almost entirely Eurocentric.

An interesting site that teachers might consider using as a learning aid is the set of maps illustrating each of the UN's seventeen Sustainable Development Goals (SDGs) produced by the International Cartographic Association (ICA). The project mapped each of the goals from the perspective of a specific ICA Commission to provide an overview of the strengths of cartography, including diversity of mapping options and of multiple map perspectives. It offers free downloadable posters for classroom use; for instance, maps for SDG 8 (Good Jobs and Economic Growth) usefully challenge the way colour can be used to create certain connotations. Others are less successful, but offer opportunities for critical engagement, for example the map for SDG 9 (Industry, Innovation and Infrastructure) which uses a so-called '3D extrusion' technique that, on a non-equal-area map, creates a visually confused product. Sadly, there is little consistency in the use of projection for their world maps: many, despite being appropriate, are certainly not equal-area. For example, two map projections are used to display terrestrial ecoregions (SDG 15); the first, the Mercator, is quickly dismissed as too distorting of area. Then the Winkel Triple is suggested as a substitute, based on the claim that it 'is very well suited for mapping the entire world', and despite still exaggerating the area of higher latitudes. One example (SDG 12) even uses what appears to be a Van der Grinten projection or similar, which massively exaggerates the higher latitudes, and in one version manages to drop New Zealand, a significant cartographic blunder! The only world maps in the collection to use a non-Eurocentric format are those focused on the oceans (SDGs 14 and 15). Why not at least one 'turnabout' map in a series focusing on global development issues?

It is difficult to do more than scratch the surface in such as short article. A key word search of the web will provide numerous other sites detailing the significant characteristics of specific projections. The key issue is to always ensure the chosen projection does the correct job of work! | **TG**

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Websites

ArcMap Projections toolkit (ESRI) – http://desktop.arcgis.com/en/arcmap/10.3/tools/coverage-toolbox/an-overview-of-the-projections-toolset.htm

Mapping Our World (Oxfam) – www.oxfamblogs.org/education/mapping_our_world/mapping_our_world/l/home/index.htm

Maps and Sustainable Development Goals, International Cartographic Association (ICA) – https://icaci.org/maps-and-sustainable-development-goals

Reddit 'Maps without NZ', created by people concerned about New Zealand being left-off maps – www.reddit.com/r/MapsWithoutNZ

Worldmapper – https://worldmapper.org