A way to look at geographical movement:

In this note movement is considered between geographical places identified by geographical coordinates of the beginning and ending locations. This movement may consist of a single person (or other entity: an idea, artifact, commodity, etc.) or multiple persons. The path taken is not considered and the movement takes place during some specified time interval. The assumption is made that there may be many moves, from dozens to millions.

The pair of locations, as point locations can be rendered as one directed line (arrow), as between points on a map, and the entire group of movements as many arrows. An example is shown in the first illustration: Journey to Work in the Detro 10 vicinity. All this is well known. It is also conventional, when many movements are involved, to group beginning and ending locations into aggregated locations: separate little pieces of territory. These are often counties, census tracts, states or countries, etc., irregularly shaped polygons on the earth's surface. The movement between these areas can be shown in a similar manner to that of point location data, generally using area centroids. This is shown in the next figure, having made using the Flow Mapper program from C S I S S .org.

What I would like to suggest now is that one may imagine shrinking these areal units into small size, really infinitesimally small, and then to consider the movement pattern in a spatially continuous fashion. This can be done by introducing a grid, or raster, over the domain and reassigned all of the movements to the nodes in this grid. This is accomplished by smoothly spreading all of the movement from (or to) an area over the nodes bounded by each of the movement reporting areas. Such a raster covering the contiguous United States is illustrated here.

A suggested next step is to consider the difference between the incoming and outgoing moves within each area, in the raster assignment. Thus some of the areas (i.e., raster nodes) will get positive numbers and some will have negative numbers. Imagine that the negative numbers are high hills and the positive numbers represent low valleys - i.e., you have a kind of topographic surface. Now let the movement quantities move downhill, like topography eroding. The movement arrows are now the gradients to the "movement surface", and can be shown as a vector field. Connecting these gradient vectors can render this as a streamline movement pattern.

The example shows these ideas using a U.S. Census Bureau 48 by 48 contiguous state-to-state migration table converted in this fashion. The hills are the out-migration quantities and the low places, e.g., Florida, are the in-migration places. The resulting movement pattern clearly delineates source and sink domains describing the net spatial pattern of migration. In this particular depiction sixteen million people are migrating: the trajectories are ensemble averages, not individual moves. But migration to the Northwest, Southwest, Southeast, and Northeast are clearly distinguished. That this migration map resembles a map of wind or ocean currents is not surprising given that we speak of migration "flows" and "backwaters" and use many such hydrodynamic terms when discussing migration and movement phenomena. The appearance is that of laminar flow, due in part to the coarse resolution of the data.

The suggestion is that this continuous type of movement pattern analysis can be used in other situations, such as movement within a city, perhaps based on data assembled from cellular phone observations when connected to GPS locations. Many other such situations come to mind. For example, taxes collected and entitlements disbursed, both by congressional district.

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