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National Centre of Competence in Research
Research Partnerships for Sustainable Development

Report on
Migration and Mobility Data Visualization Workshop

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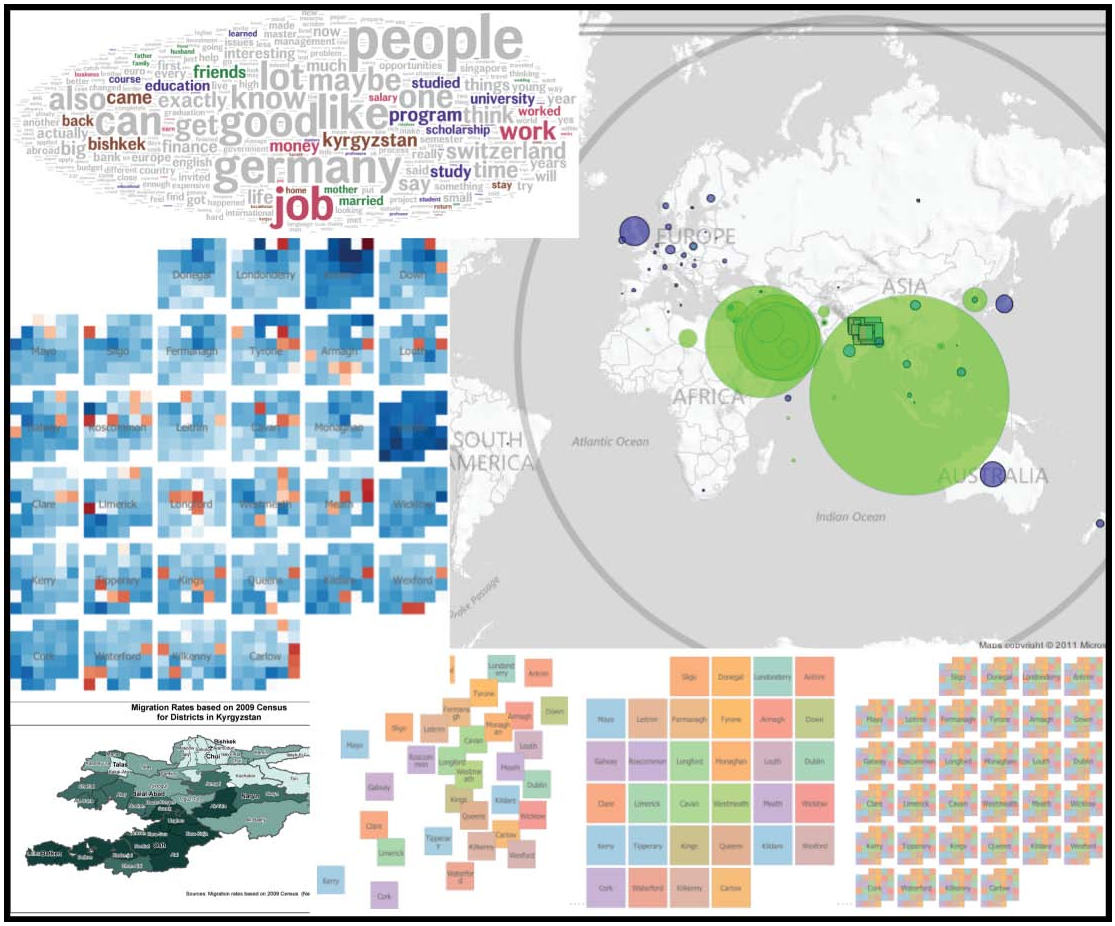

With contributions from:
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We are also very grateful to Ulrike Müller-Böker, for her contribution of ideas as well as financial resources particularly at the initial stage of the project and her continuous feedback while the workshop was developed. Furthermore, the very collaborative supervision of two Master's students (Patrizia Russo, Julian Hull) with Arzu Cöltekin, University of Zurich and the excellent work by Nadia Schoch (Schoch 2010) provided very important first insights in order to be able to set up the project proposal and workshop later on.

Abstract

Migration and development has become a topic of high interest especially in countries of the global South. With increasing interest, academia as well as policy makers identify the lack of high quality migration data as one major obstacle for forming policies and maximizing the benefits of migration. Next to data availability, a major challenge is to effectively represent, analyse and visualize large and highly dynamic datasets. The overall goal of the workshop was to support new insights into patterns of migration and interlinkages with development by screening and evaluating existing data of researchers within and outside the NCCR North-South and creating effective visual support to explore datasets and create knowledge that cannot be established by looking at raw data.

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1 Introduction and background

Migration and development has become a topic of high interest in many countries around the world. Academia as well as policy makers acknowledge that further qualitative as well as quantitative research is needed to address migration and mobility issues and to elaborate policy recommendations and implementations. Next to quality and coverage, accessibility of such data also has to be improved to provide an enhanced evidence base (Black and Sward 2009; Skeldon 2008, HDR 2009). The rationale for the workshop took reference to two debates: (i) availability and quality of statistical migration data, and (ii) analysis and visualization.

(i) Availability and quality of quantitative migration related data

Despite an increasing interest in global overviews of migration patterns, comprehensive and reliable data, in particular statistics continue to be poor (Parson et al. 2007). A lack of better migration data is seen as a major obstacle to formulate policies and maximize the benefits of migration (Santo Tomas, Summers 2009: 3f.). For example, out of 230 countries only 121 had data on their international migration stock in 2008. Even in the case of countries of the North, comparisons are often difficult to make for very basic reasons, such as differences in the definition of migrants (UNDP 2009: 12, also Schoch 2010).

The source of information is another major challenge for gaining a global overview of migration given the different conceptualisations of migration and the varying quality of data (Raymer 2007, Schoch 2010). The main global data providers for tabulations based on empirical data are United Nations Population Division, OECD, Eurostat and, for tabulations based on estimates, the Sussex Development Research Centre on Migration, Globalisation and Poverty, UNDP and World Bank (Santo Tomas, Summers 2009: 6; Schoch 2010). IFAD, World Bank and IMF provide data on remittances, i.e. the amount of transferred money by foreign workers to their home country. All the above-mentioned institutions provide only national migration data. One has to approach national statistical authorities directly to access data below the national level, which in many cases demands on site research (Schoch 2010).

(ii) Visualization

Despite all the limits outlined above, reliable data and statistics are needed. There is little alternative to documenting and processing the raw data available from individual countries, while pragmatically acknowledging the unavoidable shortcomings. (http://www.migrationdrc.org/research/keythemes/data.html, 17.April 2010) Visualisation of migration flows is critical for understanding movement of people. Although cartographic literature often suggests flow maps to visualize migration flows, creating an effective visualization for migration flows remains a challenge to cartographers (Xiao and Chun, 2009). For migration researchers as well as for informed political decision making, a simplification of flows from origins to destinations is not enough. Instead, " … an effective visual support is needed … to acquire knowledge that cannot be established by just looking at the raw data",

which is important to understand patterns of migration (Xiao and Chun, 2009: 183). Therefore, an effective representation, analysis and visualization of existing data remain challenges to the research community (Shaw et al., 2008: 426). Furthermore with the rise of the World-Wide-Web, geographic visualizations are very easy to distribute and can be accessed by a broad audience (Dodge et al. 2008). The World-Wide-Web therefore offers an opportunity to bridge the information and knowledge gap between countries of the global North and South. The process of geographic visualisation, however, is always dependent to a large degree on available data and methods of data collection (also Dodge et al. 2008: 6)

2 Aim of the Workshop and Preparatory Work

The workshop aimed at exploring and using the potential of visual representations in order to discover hidden patterns and relationships between migration, mobility and development concealed in mainly large but possibly also smaller datasets. Jo Wood and Aidan Slingsby from City University London working in visualization research ensured an effective kick-off into visualization methods from migration data. The workshop was based on active participation to ensure visual output of migration data. As a preparatory step, participants were asked to send their own generated data (e.g. household surveys) or secondary data (e.g. statistical yearbooks, UN data bases etc.) that they want to work with in the workshop for data preprocessing before the actual workshop.

By bringing together experts on migration and mobility as well as geovisualisation, the workshop intended to contribute to the process of data compilation. This creates meaningful and usable visualisations to represent qualitative data as well as larger multi-variate spatio-temporal datasets for global and regional overviews of migration as well as to explore and use the potential of visual representation to be able to discover hidden patterns and relationships between migration and development concealed in large datasets. In addition, the produced visualisations also underline already gained insights from existing research from collaborators within and outside the NCCR North-South. An equally important intention of the workshop was to explore data through visualisation in order to generate new research questions and ideas.

The goals of the workshop were successfully achieved by implementing a whole series of visualizations for different research questions (see Results section), such as student and labour migration in Nepal, internal migration in Kyrgyzstan and Ireland, and transmission of diseases in Africa. Additionally, the integration of qualitative and quantitative data was kick-started (launched) by using coloured word clouds, which allowed the exploration of interview data with a quantitative perspective, generating new research ideas.

The remainder of the report is the documentation of the workshop and its results.

3 Participants of the workshop: (alphabetical order)

Participants of the workshop consisted of researchers with key competences in migration and mobility research, as well as visualization experts dealing with mobility data. The following list gives an overview of full-time attending participants.

Anita Bhattarai Ghimire	Post-doc, Migration studies Swiss National Center of Competence in Research North-South, Regional Coordination Office, Nepal	NCCR affiliated
Mary Kelly	PhD Student, Geography, NUI Maynooth, Ireland	
Mathurin Koffi	Assistant Professor, Epidemiology, Centre Suisse de Recherche Scientifique, Abobo-Adjamé University, Abidjan, Ivory Coast	
Anna-Katharina Lautenschütz	Post-doc, Geovisualisation, University of Zurich, Switzerland	NCCR affiliated
Bakhrom Mirkasimov	PhD student, German Institute for Economic Research (DIW Berlin), Berlin, Germany	NCCR affiliated
Ross Purves	Professor, Geocomputation, University of Zurich, Switzerland	
Esther Schelling	Senior Researcher and project leader, Swiss Tropical and Public Health Institute, Basel, Switzerland	NCCR affiliated
Aidan Slingsby	Research Assistant, GICentre, City University London, London, Great Britain	
Susan Thieme	Senior Lecturer and Research Associate, Human Geography University of Zurich, Switzerland	NCCR affiliated
Jo Wood	Professor, GICentre, City University London, London, Great Britain	

Additionally, two participants from the University of Zurich participated part-time, namely Arzu Cöltekin (Senior Researcher Geoinformation and Visualisation) and Ulrike Müller-Böker (Professor, Human Geography).

Background of Participants

At the start of the workshop all participants presented their own research questions and aims for the workshop in order to find a common set of aims and set-up a working plan for the week. In the next couple of paragraphs we summarize participant's main interest in migration data and their expectations for the workshop:

Anita Bhattarai Ghimire is mainly interested to understand the motivation of Nepali students to study abroad and return to Nepal for working, thus situating student migration in Nepal's migration trends. Census data for both labour and student migration are available, including

where they go, where they come from, their educational status, potential host country and demographic data. Additionally, qualitative interviews were conducted to understand students' migration motivation. However, it is unclear which indicators are most useful to explain their migration behaviour, as well as how to integrate qualitative and quantitative data.

Bakhrom Mirkasimov would like to visualize demographic changes in household and community data to compare temporal and regional variations, as well as comparing migrant and non-migrant household profiles. Census data are available for 2009 and 2010 with less than 10 variables. Additionally, an individually randomized sample for all seven oblasts (Kyrgyzstan administrative unit) and two cities in Kyrgyzstan is available with 10-50 variables. The communities are geocoded. His goal for the workshop was to visualize migration patterns on a community and a regional level for Kyrgyzstan.

Mathurin Koffi is working on the spreading of an infectious disease (Human African Trypanosomiasis - sleeping sickness) in Africa, specifically the Ivory Coast. The disease spreads through the tsetse fly and is carried onwards by labour migrants. Understanding the internal and external movement of season migrants is necessary to target surveillance for reoccurrence. A health survey has identified sick migrants and has documented their location information through GPS fixes. The dataset consists of approximately 100 persons who are infected with the disease and their respective location through place names. However, no information is available where people migrate to and from, therefore no temporal dimension is available for the understanding of the spreading of the disease.

Esther Schelling works on migration routes of mobile pastoralists in Chad in order to set up a vaccination programme. GIS data are available for the migrant regions and cover the main routes and itineraries of the migrants. This data is georeferenced based on participant mapping. Case studies also exist of routes according to ecological zones, e.g. pasture. Demographic and health surveys were conducted with phone interviews and household surveys, but available data is limited. A key goal is the visualization of the level of uncertainty in the data, as well as identifying how to visualize the mobility and flexibility of the pastoralists.

Mary Kelly works on historic migration data from Ireland and specifically examines male and female mobility at two points in time (1851,1911). Data are available on a county level for 1851,1911, and 1961. Her goal is to examine changes in internal and international migration in Ireland with new ways for visualizing mobility data. Possible variables are distance, population size, destination, as well as occupational structures.

Susan Thieme works on migration and multilocal livelihoods in South and Central Asia. Her main goal for the workshop is the integration of qualitative and quantitative data, e.g. using interview data and photographs combined with classical census data. Also, she would like to use visualization tools as a method to generate new ideas and knowledge while exploring her data.

4 Programme

Monday, 21.5: Intro to Visualisations & identification of common goals

07:50 - 09:15	Travel to Einsiedeln,
09:45 – 12:00	Welcome to Workshop (Anna-Katharina Lautenschütz) Introduction & State of the Art on Migration Statistics (Susan Thieme) Keynote on "Visualization Universe" (Jo Wood)
12:00	Lunch
13:30-15:30	Presentation of Problems & Goals of Participants
15:30 – 16:00	Coffee Break
16:00 – 18:00	Definition of Goals and Projects for the Workshop Formation of Project Groups
18:00	Dinner
19:30 – 20:30	Kick-off Group Projects

Tuesday, 22.5:	**Intro to basic GIS**
08:00	Breakfast
08:30 – 10:00	Introduction to GIS & Fusion Tables (Ross Purves)
10:00 - 10:30	Coffee Break
10:30 – 12:00	Project Work
12:00	Lunch
13:30 – 15:30	Project Work
15:30 – 16:00	Coffee Break
16:00 – 18:00	Project Work
18:00	Dinner
19:30 – 21:30	Progress Report

Wednesday, 23.5: Visualizing Movement Data

08:00	Breakfast
08:30 – 10:00	Applying Visualizations to Movement Data (Aidan Slingsby)
10:00 - 10:30	Coffee Break
10:30 – 12:00	Project Work
12:00	Lunch
13:30 – 15:30	Discussion on Challenges with Migration Data
15:30 – 16:00	Coffee Break
16:00 – 18:00	Project Work
18:00	Dinner
19:30 – 22:30	Progress Report & Project Work

Thursday, 24.5: Collecting and maintaining migration data

08:00	Breakfast
08:30 – 10:00	Project Work
10:00 - 10:30	Coffee Break
10:30 – 12:00	Statistical Acquisition of Migration Data (Marcel Heiniger – Swiss Federal Office of Statistics)
12:00	Lunch
13:30 – 15:30	Project Work
15:30 – 16:00	Coffee Break
16:00 – 18:00	Excursion to Monastery
18:00	Dinner
19:30 –	Project Work

Friday, 25.5:

08:00	Breakfast
08:30 – 10:00	Project Presentations by Participants
10:00 - 10:30	Coffee Break
10:30 – 12:00	Discussion & Wrap-up of Workshop
12:00	Lunch
13:30 – 15:30	Return to Zurich

Date, Place: May 21-25th 2012, Einsiedeln, Switzerland

Identification of common goals for the workshop

The first day of the workshop aimed at bringing together researchers with expertise in visualization and migration to identify key goals for the workshop. Common goals among the migration experts were to map their own data, for instance with open source tools, as well as to deal with uncertainty of data. In the evening, clear goals and working groups were defined for the remainder of the workshop:

1) Producing a treemap representation for different social and economic variables of Kyrgyzstan ond a community level. (Aidan & Bakh)

2) Mapping internal and external migrant populations coming to Cote d'Ivoire with a 100 GPS-point dataset. (Ross, Mathurin, Esther)

3) Creating OD Maps for Irish Migration. (Mary & Aidan)

4) Create OD Maps for labour and student migration of Nepal (Susan, Anita, Jo)

5) Explore qualitative data with Word Clouds, Phrase Nets and Word Trees (Susan, Anita, Jo)

5 Results

1 Coloured Word Clouds

1.1 Context

In a research project on student mobility, interviews were conducted in Kyrgyzstan in 2011 with people who studied abroad and had subsequently returned after their studies. The interviews mainly covered questions about the studies abroad, reasons to return, experiences of the actual return, integration in the labour market and social aspects including family life. Interviews were conducted with an interview guideline in English or German. When interviews were held in Russian or Kyrgyz, the translation was done during the transcription. Interviews lasted between one and two hours.

The word cloud is based on one interview of a returnee and shows a summary of the whole transcript. The clouds give greater prominence to words that appear more frequently in the source text. The programme is open access (http://www.wordle.net/). We have two types of word clouds. In the first cloud, words and colours are matched randomly (Figure 1). In the second word cloud Figure 2 we intend to visualize categories, which were developed out of the analysis and interpretation of the data material. For example, the topic "education" is coloured in purple in the word cloud together with other words such as "study", "course" or "programme" allowing the viewer to observe that these are related to the topic of education.

Figure 1: Unclassified Wordcloud for Interview Data from Kyrgyzstan

Figure 2: Coloured Word Clouds for Interview Data from Kyrgyzstan

1.2 Methods

Transcripts for each interview had questions from the interviewer removed and word frequency analysis was applied to each interviewees responses. The following stop words were removed from analysis:

about after against am and are as be been being between but can't could did do doesn't don't during few from had has have having he'd he's here hers him his how's i'd i'm if into isn't it's itself me most my no not off once or ought ours out own shan't she'd she's shouldn't some than that's their them then there's they they'll they've those to under up was we we'll we've weren't what's when's where's while who's why with would you you'll you've yours yourselves

Keywords were classified into 4 groups and colours applied accordingly, with all other words coloured grey:

Education:

academia academic campus course courses degree department dissertation educated education educational graduate graduated knowledge learn learned masters phd professor professors program research scholar scholars scholarship school skilful skill student students studied studies study studying taught teach teacher teachers teaching textbook textbooks training tuition universities university

Family

baby birth boyfriend child children daughter daycare families family father friend friends husband husbands kids married maternity mother parents paternal pregnant relationship relatives son wedding

Work

business companies earn economic funding job jobs money pay professional promoted salary skills stipend work worked working works

Home

away back bishkek came home homesick hometown kazakh kazakhstan kyrgyz kyrgyzstan leaving left return returned returnees stay stayed uzbekistan village went

Word frequency data were submitted to Wordle (www.wordle.net) with the following settings:

Language: 'Remove numbers' 'Leave words as spelled'; 'Do not remove common words'
Font: 'Meloche Rg Bold'
Layout: 'Maximum words: 9999'; 'Prefer Alphabetical Order'; 'Rounder Edges'; 'Horizontal'

1.3 Content

Interpretation
The word cloud provides a very first overview and impression of the general variety of words used in the interview and their frequency. The more frequent the word the more prominent it

appears. It is interesting to see which words appear more often than others and those which do not show up at all. It was interesting for us to see at a glance words which we did not expect to appear so often ("time" in one wordcloud, for example). Especially interesting is to compare different wordclouds of interviews because it allows an immediate understanding of the content of each interview (although not the context) and helps to raise interesting questions when approaching the material in a more detailed manner at a later point.

Limitations

The word cloud does not tell you the context in which the words are used and thus does not allow a detailed interpretation of the interview context. In addition, most of the interviews are not held in the interviewee's native language (which would be Russian or Kyrgyz). Therefore the vocabulary is often limited, which has to be kept in mind while interpreting word clouds. Also the categorisation mentioned is only possible by an in-depth analysis and interpretation of the text.

Added Value

The visualisation provides an excellent first impression of the content of the interview and potentially highlights words, which might have been overseen with standard-coding. Although not allowing an in-depth interpretation, it nevertheless raises new ideas and questions for approaching the interview material.

Those visualisations are particularly beneficial when sharing data. Simple word clouds can be very easily processed and can provide a common basis for starting to discuss the content of interviews.

Next to the explorative value, the word cloud is also a very approachable and easy to understand visualisation which makes it a very useful presentation tool for interview data.

2 Migration Maxtrix OD Map

2.1 Context

The objective of the research was to be able to see and compare the dynamics of emigration and immigration from each country for which the data were available. It also aimed to achieve an understanding of where the flows are stronger or weaker than others. For example, to see which country receives migrants, the number of migrants received from a particular country and in turn where migrants come from in that particular country.
Link to interactive map: http://www.soi.city.ac.uk/~jwo/migration

2.2 Content

Interpretation
The visualization helps to understand data and extract patterns by making it possible to see through all the available data in a single picture. Arrows, for example, showing the movement instead of numbers, allow the researchers to analyze data, see patterns, and compare them for interpretation at one glance. Secondly, this representation explicitly shows patterns of flow (and stock of migrants) and thus it is difficult to ignore certain dynamics, which could have been missed before, as it makes explicit where the flow is stronger or weaker. It could be an important way for minimizing errors caused by a limited understanding of country specific migration patterns. For example, we may have the impression that most people from Mexico migrate out, but the visualization shows that Mexico also receives a lot of migrants from other countries, while additionally also showing which countries these migrants are from. This could be an important insight for looking further into the migration dynamics of Mexico and could trigger an interest to explore the topic in further detail.

Limitation
Certainly, this visualization is user-friendly and interactive, but a limitation is that the OD map is very data "hungry". In migration studies, the lack of high quality data is one of the main obstacles to study and analyze this topic. Hence, it could over represent spatial movements around the world where the national statistics on the flow and stock of migrants is better recorded, and underrepresent those parts of the globe where you find almost no data on migrant movements (e.g., migration to Russia). Additionally, there is also no unified/common definition of a temporary labour migrant vs. permanent labour migrant, and the main source of global migration information is the population censuses of individual countries. This factor alone makes the visualization problematic since it does not visualize differences in data collection practices and therefore can only capture past patterns of migration.
As already mentioned, it adds value to our research because it gives us new possibilities to compare national migration data. This helps in making a better analysis and interpretation of data, including identification of countries where the data collection processes could be improved. It also has the possibility to make different emergent themes more explicit. It also facilitates exploring new research questions and knowledge generation. Finally, the visualization is very clear and lively and thus serves as a representation tool.

3 Kyrgyzstan GIS Map – internal emigration rates

3.1 Context

The aim of this workshop task was to be able to map migration rates across Kyrgyzstan based on 2009 Census provided by the National Statistical Committee of the Kyrgyz Republic. Migration rates were mapped on a basic choropleth map showing the migration rate of Kyrgyzstan's oblasts (i.e., districts) in percent, i.e. the amount of migrants by population. The map is at the district level, which allows the domain expert to identify migrant communities and is the first one to represent migration rates on this spatial level, i.e. district level.

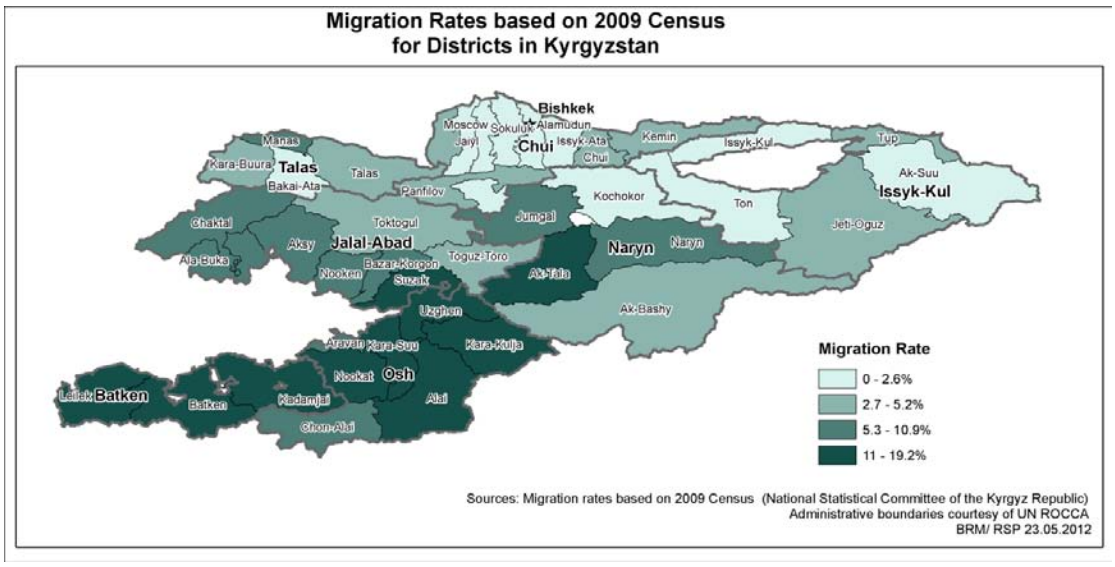


Figure 3: Migration Rates displayed in a classical GIS map

3.2 Methods

The map produced shows rates of migration for individual districts (Rayon) in Kyrgyzstan. Districts and upper level administrative units (Oblast) are labelled, along with the capital of Kyrgyzstan. The legend uses quartiles to display migration rates. The map was prepared in ArcGIS, after an attempt using QGIS, where it became apparent that our skills were not sufficient to produce a well-labelled map, whereas in ArcGIS the label placement algorithms greatly facilitated this task.

1) The statistical data were initially prepared in Excel, with migration rates being calculated and stored in a CSV file along with district names.
2) Spatial data were received from the UN representing the boundaries of both levels of administrative unit as a shape file.
3) A join was made between the statistical data and the spatial data to allow migration rates to be displayed.
4) An appropriate legend, using quartiles was selected, and colours based around a ColourBrewer scheme (www.colorbrewer.org) for sequential values selected.
5) Labels were positioned on the map using ArcGIS's label placement capabilities, and adjusted by hand to reach a reasonable solution.
6) Bishek's label was added by hand.

Data

Absolute values for migration and population per district were based on the 2009 census and provided by Bakh Mirkasimov. Spatial data were received after e-mailing the UN representative in Almaty (see http://cod.humanitarianresponse.info/country-region/kyrgyzstan for more information).

Limitations

Label placement could still be further improved. Any choropleth map is subject to problems related to the actual borders used and the related representation and inferences drawn (for example the ecological fallacy and the modifiable areal unit problem). Such issues would be important here if districts did not well capture population distributions, with for example a large district such as Ak-Suu having extensive migration except from a single urban centre where a non-migratory population was concentrated. The impression of low migration from this large region would then be incorrect.

3.3 Content

Interpretation

This migration map is the first of its kind for Kyrgyzstan because it maps migration rates not just at the aggregate "Oblast/Region" level but does so at the "Rayon/District" level. This is very important and unique because it gives you an idea which Rayons within an Oblast and across Oblasts have the highest or lowest migration rate. Now, anyone may clearly identify the migration rates within and across Oblasts and address any specific migration related questions and challenges at the Rayon level.

Limitation

One limitation is that it may be difficult to re-produce such maps without having access to any GIS software/materials or GIS expert. Any software requires time to learn its craft and be able to map any other variable (i.e. available in the Census – unemployment rates, etc). It might also become hard to read labels if you include too many variables.

Added Value

"One picture is worth a thousand words" can be applied here because this map takes a complex set of data/numbers and conveys it in a single geo-spatial image. It shows a large amount of data quickly and it is easy to read and understand. It certainly and quickly tells you which Rayons of Kyrgyzstan that you need to focus due to very high migration numbers if one is interested in studying the impacts of migration in Kyrgyzstan.

4 Sleeping Sickness Map (HAT)

4.1 Context

Human African Trypanosomiasis (HAT) is a disease that is vector-borne and typically occurs in sub-Saharan remote rural areas. Migrants infected by the disease through the tsetse fly often transport the disease across borders. Understanding the dynamics of these migration populations is important to eliminate HAT. The map produced in this workshop (see Figure 4) uses pie charts on a basic GIS map to identify the different ethnic groups of migrants. The size of the pie chart reflects the number of people returning to their home country or other regions in Cote d'Ivoire. Data availability was too coarse to produce flow maps for a more enhanced understanding of migration routes. Therefore individual GPS points as locations of migrants were not mapped.

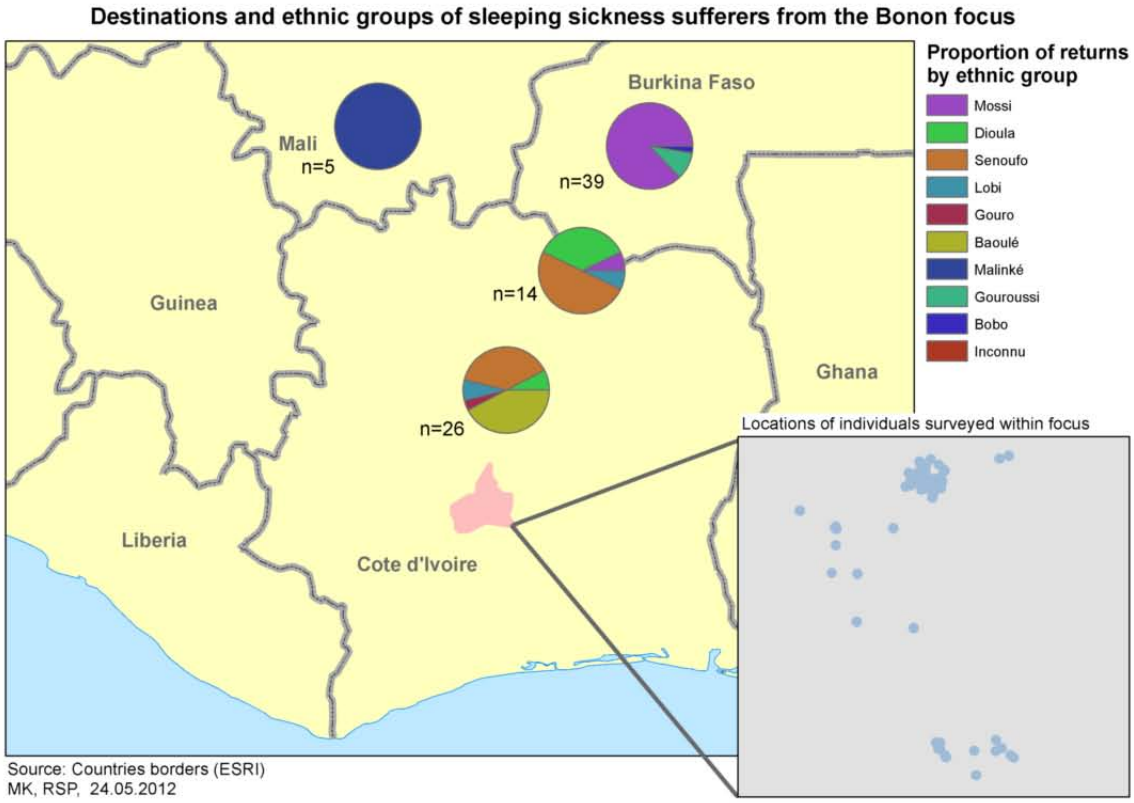


Figure 4: Sleeping Sickness Map of Ivory Coast displaying destinations and ethnic groups of sleeping sickness sufferers

4.2 Methods

The map (Figure 4) shows potential return locations of sleeping sickness sufferers from a small focus region of the disease in Cote d'Ivoire. The portrayal is very simple because the data available were very coarse. The map was produced in ArcGIS.

1) The background map, consisting of country borders and underlain by a blue area representing sea was prepared. Since very limited other topographic data were available, only country names are shown.
2) The pie charts are based on an Excel spreadsheet detailing contact and ethnic groups of sleeping sickness sufferers in the disease cluster.

3) The pie charts were repositioned by hand to represent the countries of return, and a cluster which related to an ethnic group found on the border and within Cote d'Ivoire. Importantly, no information about actual locations (beyond the country level) was available; rather Mathurin Koffi provided an interpretation of the likely destinations of the individuals.
4) Since any case of sleeping sickness is a potential cause for concern, the pie charts are not scaled according to the number of incidences – rather a value for n for a particular cluster is shown.
5) GPS data were available which position the individual sufferers at their interview locations in the disease focus. These are shown in an inset map, and the region associated with the outbreak is also shown.

Data

Mathurin Koffi provided the epidemiological data. Background data were sourced from http://cod.humanitarianresponse.info/country-region/c%C3%B4te-divoire and ERSI datasets provided with ArcGIS. Very limited topographic data were available for Cote d'Ivoire.

Limitations

The data portrayed in the map are very imprecise, and arguably could be equally well represented without recourse to a spatial representation. The disease cluster locations may not relate to locations of the sufferers, and in any case no contextual information is available, so they are not readily interpretable. The region associated with the disease focus, shown in pink, is much bigger than the actual disease focus.

4.3 Content

In the context of elimination of HAT as advocated by the World Health Organization, it is important to take into account all factors that may promote the maintenance or the recrudescence of the disease. This work has consisted of mobility's traceability of former HAT patients using GISsciences tools for population movement visualization.
It appears that a significant proportion of these migrants return to their home areas often free of the disease but where tsetse flies are present. Through close cooperation of HAT national control programmes of Côte d'Ivoire and Burkina Faso, a country where the proportion of migrants is highest in Côte d'Ivoire, some patients who have failed to be detected in Côte d'Ivoire are detected in their home country. This collaboration helps to track the movement of migrants working in areas under influence of tsetse. Although this map is giving the opportunity to know the proportion of migrants who return to their country or region, it has not viewed the coordinates of specific points. This however does not allow to understand where landing points could be introduced for preventive measures.

5 Ireland OD Map

5.1 Context

Internal migration patterns in nineteenth century Ireland have received limited attention from geographers and population historians. The reasons for this are two-fold. Firstly, emigration has been the dominant force in Irish population history and consequently the main focus of research has been on the movement of people out of Ireland (Kelly and Fotheringham 2011). Secondly, data on internal migration from 32 counties to 32 counties on a small island are difficult to visualise. The absence of research on internal mobility in Ireland has resulted in the perception that people who did not emigrate stayed very much at home. The purpose of this work is to explore the geographical mobility of Irish people in both 1851 and 1911 and to consider if and how mobility changed in that time frame.

Figure 5: Construction of an OD map: Left: counties represented as squares in their geographical locations. Middle: counties arranged in a grid, retaining much of their spatial arrangement. Right: mini maps are embedded into each of the county squares represent destinations (smaller squares) of the origins (large labelled squares). Colours help identify the counties.

5.2 Methods

We used OD Maps (Wood et al, 2010) that can depict flow densities between these counties. Birth (origin) and residency (destination) counties for individuals in the 1851 and 1911 Irish censuses were used to construct an origin-destination matrix as a proxy for internal migration. Advantages over other commonly used representations are that they preserve some of the spatial structure (unlike OD Matrices) and are non-occluding (unlike the mass of crossing lines that flow maps often produce). However, they are a relatively new and unfamiliar technique.

5.3 Content

Figure 6 indicates that there is some symmetry in internal migration, but there is also asymmetry; for example that migration into Antrim is greater than out of Antrim. Much of the migration is to nearby counties, except for migration in and out of Dublin. For reasons of space, we have not shown the 1911 maps because they have similar overall patterns (plotting difference is more effective; see Figure 8). Logarithmic colour scales are used to show variation across the different magnitudes of migration, but it is important to note that it does this by exaggerating low numbers of migrants more than high numbers,

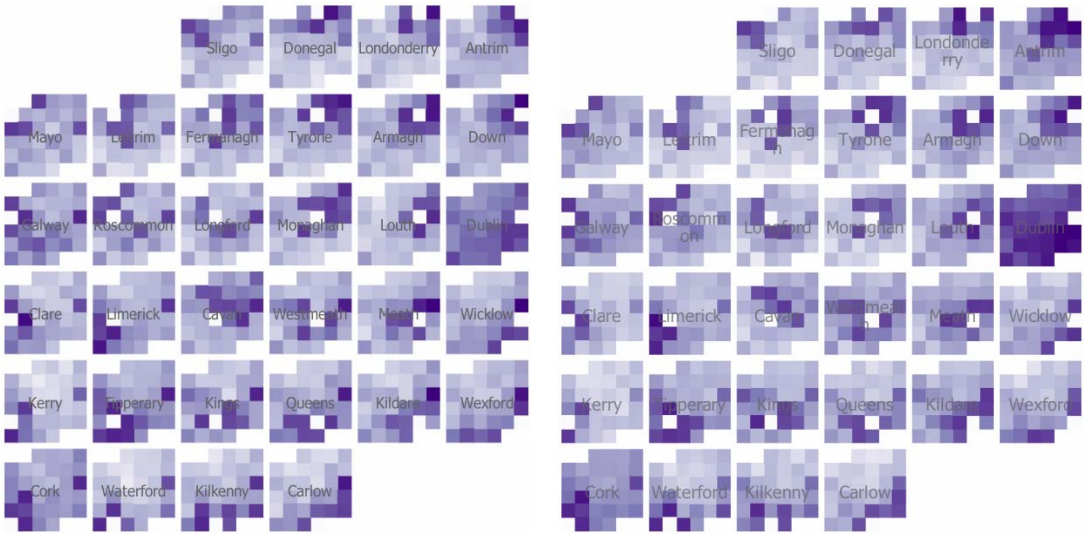


Figure 6: 1851 Maps. Left: OD Map showing flow densities from origins (large squares) to destinations (small squares) on a logarithmic scale. The large Dublin square shows where Dublin people went. Right: Origins and destinations have been reversed, where the large Dublin square shows where people who arrived in Dublin came from. White squares are where both origin and destination are the same.

Figure 7: OD Maps coloured by percentage of all out-migrants on a linear colour scale. Darker colours therefore indicate destinations of higher preference. Left: Destinations (small squares) by origin (big squares). Right: Origins (small squares) by destination (big squares).

Figure 6 shows absolute numbers, so we would expect values to be higher for counties with high populations. It shows that in 1851 people either migrated to neighbouring counties or to Dublin. We tried numerous options for normalising these numbers. In Figure 7, we normalised these flows by the out-migrant population. It shows that migration from some counties (e.g. Kildare and Down) is mainly to one single neighbouring county, whereas migration from others (e.g. Monaghan) is to more destinations. Switching the origins and destinations around shows Dublin as the most popular destination, but that other counties are important destinations for more local catchments.

Finally, we found that colouring OD maps by the difference between the two years was the most effective way of comparison between years. This has been done in Figure 8. To remove differences causes by changes in country population, we normalise by the origin county

population. Red indicates fewer migrants (as a proportion of the origin county) than we would expect based on 1851 migration. Blue indicates more. Note that this uses a logarithmic colour scale.

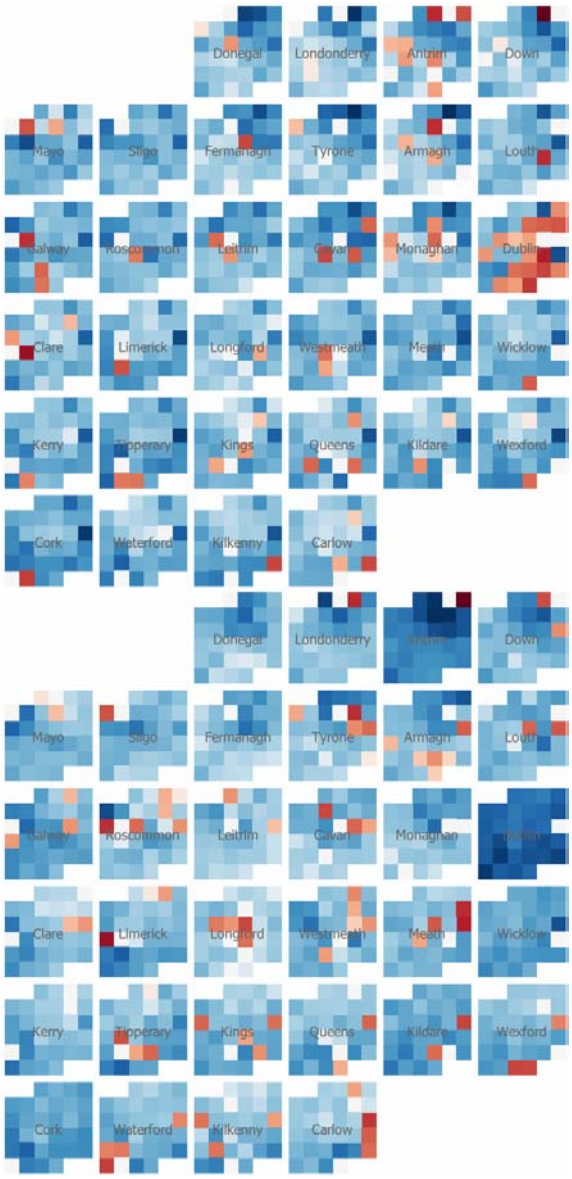


Figure 8: Differences in the number of migrants between 1851 and 1911 normalised by population, on a logarithmic scale, where red indicates fewer migrants in 1911 than we would expect based on 1851 migration and blue indicates more. Left: Destinations (small squares) by origin (big squares). Right: Origins (small squares) by destination (big squares).

Interpretation

This map shows a number of interesting changes in internal migration. Firstly, in 1911 there was less migration out of Dublin than expected, based on 1851 migration. People were also less inclined to move out of Antrim than expected. These two counties are much more popular destinations than in 1851. Secondly, provincial migrants did not favour neighbouring counties as much as they had done in 1851. Thirdly, migrants from provincial areas show less than expected movements towards provincial towns or cities (counties that contained large urban settlements). So for example Clare people shows a less than expected orientation towards Limerick or Galway as did Kerry people towards Cork, Cork people to Waterford, and Tipperary people towards Kilkenny in 1911 than in 1851. Finally, while rural migrants were not moving so much to some of their neighbouring counties or to provincial cities, overall the maps shows

that there was more migration to the majority of counties in 1911 than expected (more blue squares than red squares on this map). While the figures in many instances might represent only small increases this does show that between 1851 and 1911 Irish people became more internally mobile which can be seen as a widening of internal geographical horizons.

Limitations

A limitation of the technique is that whilst the transformation of the counties into the grid preserves much of the spatial structure, neighbouring counties do not necessarily neighbour those in the OD Map. It is not suitable to interpretations based on direct adjacency – rather it is suited for interpretations based on more general spatial patterns. Coordinate transformations (such as in Figure 1) can help mitigate this limitation.
A limitation of the software used to generate these (HiDE: http://gicentre.org/hide/) is the lack of a map legend. Tooltips allow specific values to be identified, but this may not be adequate when exporting as standalone graphics.

Added value

HiDE and the use of this technique helped us identify spatial patterns at multiple spatial scales – including those presented here – that were not otherwise visible. The exploratory nature of HiDE enabled us to map a wide variety of measures that we derived (including various ways of normalising migration by population) and allowed us to obtain details on demand.
The logarithmic colour scale in Figure 6 allowed us to see identify migration flows even where these flows were low. Figure 7 allowed us to see the relative popularity of the top destinations. Figure 8 provides an excellent summary graphic of internal migration difference between 1851 and 1911. It shows that although overall internal migration has increased between 1851 and 1911, migration out of Dublin has decreased (red Dublin squares in Fig. 4, left) except for more distant counties and that migration from all other counties into Dublin has increased (Dublin squares in Figure 8, right). Link: https://vimeo.com/45078794

6 Treemaps Kyrgyzstan & Nepal

6.1 Context

Secondary data from government and related agencies are crucial for migration research. Although problems with census data are widely acknowledged, it usually provides the most complete record of population characteristics at the time it was taken and is usually of a consistent quality nationally.

For Nepal the objective was to see the relation of the migration dynamics with the broader context like economy, total population, literacy rate on district level (a district in Nepal is an administrative subdivision of the third tier from the national level). For example, we used it to see the literacy rate of the districts and compare the number with international migration for education from those districts. Similarly we observed the relationship between the Human Development Index of each district and the number of migrants for foreign employment from each district.
For Kyrgyzstan the objective was to explore census data and demographic patterns such as the spatial distribution of ethnic groups.

The database is quantitative data from the National Censuses in Kyrgyzstan and Nepal. Census data are crucial secondary data for migration research. While on one hand the data are often challenged in terms of reliability from the researchers side, we still use it to get an understanding about general development patterns and trends. Also the quality as well as extent of data varies substantially not only as a whole but also within the different topics of the census. For example, the data that the Nepal Census provides are often questioned in terms of reliability of migration data but provides very detailed data on health issues.

6.2 Methods

Visualisation approach: Hierarchical Data Explorer (HiDE)

Hierarchical Data Explorer (HiDE) is a software tool (http://gicentre.org/hide/) that facilitates data exploration by making it easy to interactively construct graphics rapidly, some of which provide real insights into data (Slingsby et al, 2009).
The graphics aggregate by a chosen category type (such as age-range). Each category is represented as a rectangle. Size, arrangement and colour can be used to depict numerical data relating to such categories. The graphics are hierarchical, which allows other categories to be nested inside.

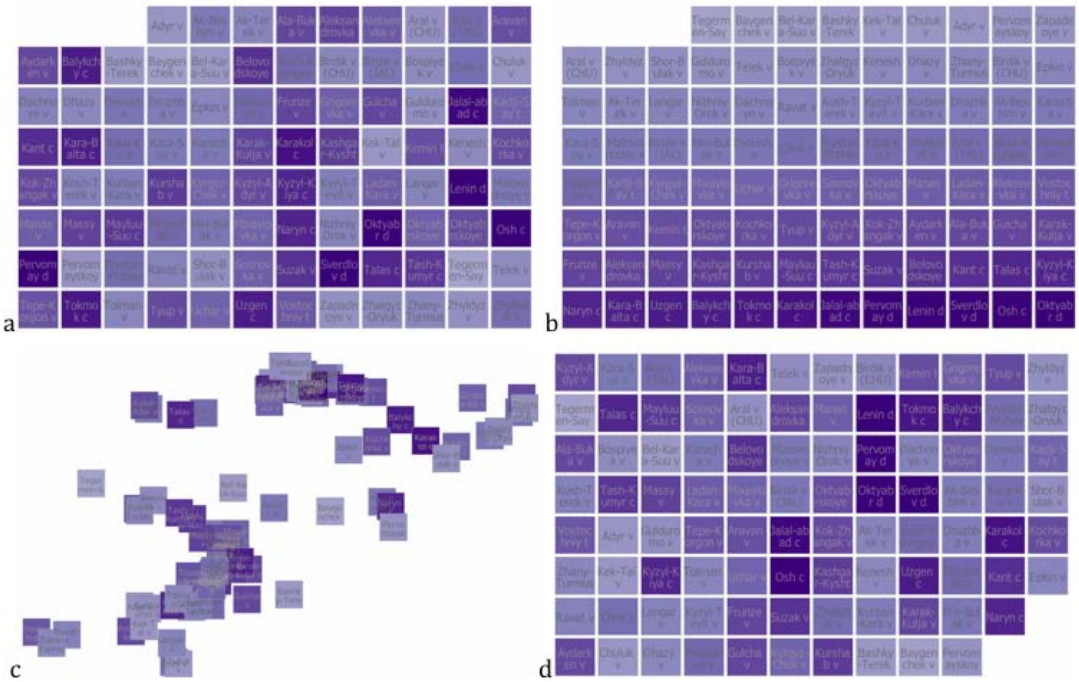


Figure 9: Experimenting with different orderings. Kyrgyzstan "communities", coloured on a logarithmic scale by population and ordered: (a) alphabetically in rows from the top left, (b) by population in rows, (c) geographically, (d) geographically in a grid layout.

shows the "communities" (administrative areas) of Kyrgyzstan in four different orderings, each coloured by population (on a logarithmic scale). Alphabetical ordering (Fig. 8a) helps one find a community with a particular name. Population-based ordering (Fig. 8b) indicates population rank. Geographical arrangements (Fig. 8c) used in maps help identify geographical patterns and may facilitate lookup if one is already familiar with their geographical arrangement, but results in a lot of occlusion. This is a common problem for geographical data within which are large variations in population density (inset maps or cartograms are common ways to address this). In Fig. 8d, we try to address this by using a non-occluding grid layout, and placing the communities as close to their true geographical position as possible, maintaining a broad geographical layout (Wood and Dykes, 2008). HiDE provides animated transitions between all these orderings, particularly useful for moving between Figs. 8c and 8d for understanding how the non-occluding spatial layout works.

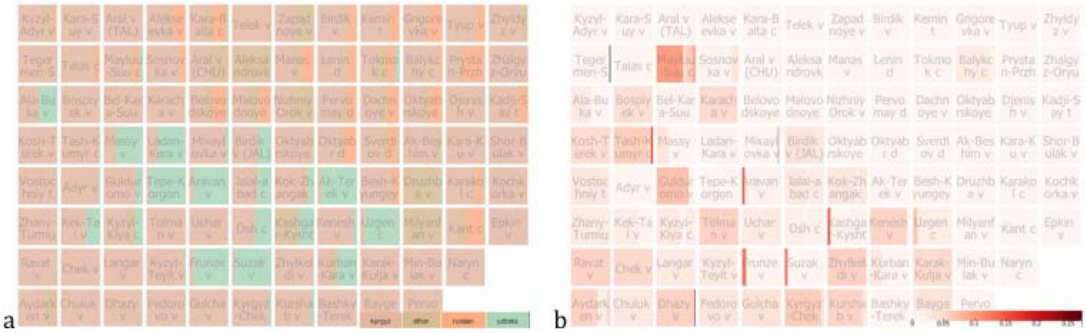


Figure 10: Nesting variables. (a) Ethnicity is nested within each community, coloured by the four ethnic groups and sized by population. Communities are in arranged geographically (Fig. 8d). (b) As before, but coloured by the proportion of the ethnic population that has out-migrated.

In Figure 10, we nest ethnicity into each community. Ethnicities are ordered from left to right alphabetically (the same order in each community), coloured by ethnicity (the same colour in each community) and sized by population, giving the population proportion in each community. The dominance of Uzbeks (green) in the southwest and Russians (orange) in the northeast reflects the neighbouring countries to Kyrgyzstan. In Fig. 2b, ethnic populations are

coloured by the proportion of that population that out-migrate. The largest numbers corresponding to small populations are probably mainly artefacts of the small sample sizes but the graphic clearly show that more of the Kyrgyz population in the southwest out-migrate than in the northeast.

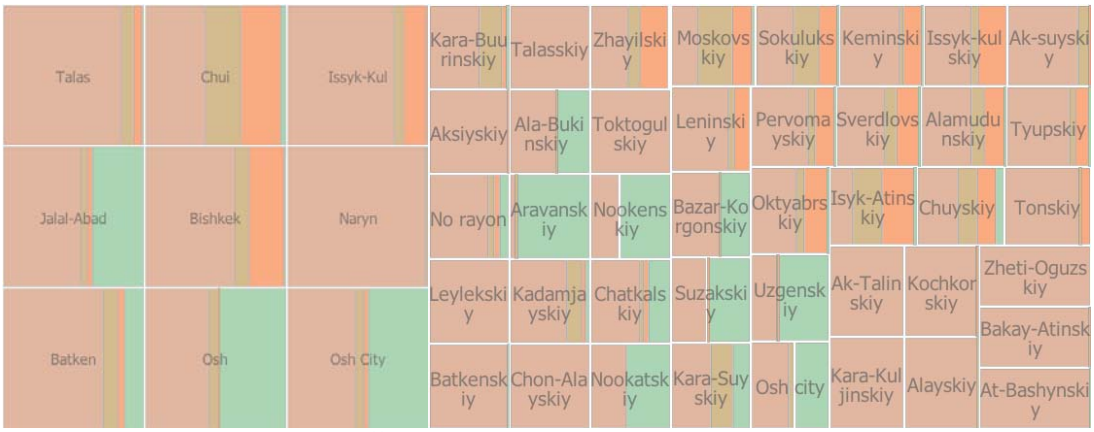


Figure 11: Exploring the data at different spatial scales. (a) Oblasts. (b) Districts.

Figure 11 demonstrates how easy it is to re-aggregate the data – in this case, to coarser spatial units.

Added value

HiDE allowed participants to rapidly explore many aspects of their data within a relatively short period of time. They found the approach and types of graphic produced to be a new and interesting way to explore and present these data.

6.3 Content

Interpretation

The treemap is a very good tool both for analysis as a researcher and to present data to the audience. For Nepal, most important was that it helped to see how migration is embedded in the larger context of each district and to get an overview of the relation between two and more variables across all the 75 districts. It therefore helped to understand and analyze data better. Apart from giving the possibility to compare different variables that relate to migration, it also helped to compare districts. Using treemaps for Nepal, for instance, we could analyse the total literate population of the district with the number of student migrants from the respective district and see at the same time how each district's values differed in a certain aspect.

For Kyrgyzstan, it makes the Census data very user friendly and easy to follow. One might look for the number of migrants by communities, rayons or even oblasts and then find the treemap a very useful tool to visualize the outcomes spatially. Instead of looking for rows and rows of information in an Excel file, any end-user could comfortably navigate through the visualizations to identify common patterns of migration by any indicator of your choice, i.e. by ethnicity, age, gender, etc.

Limitations

Using the programme and understanding the visualisations requires a certain amount of time and routine, which could be a challenge in sharing these visualizations.

One must invest time to learn the language of HiDE software to be able to visualize any migration data independently. Moreover, one should know how this software extracts/manipulates your data (either at the aggregate level, or the lowest unit-level), because any minor data change could substantially alter the landscape of any spatial map and mislead the interested viewers. An example would be analyzing the "relative" vs "absolute" number of migrants in a community that lead to very different visualizations.

Added Value

Contrary to "standard base maps," treemaps offer the possibility to present data of administrative units of a country in a different order. People who are familiar with a country often have a mental map in their mind. This mental map includes, for example: the location of cities, the marginal regions (e.g. southern oblasts in Kyrgyzstan) and wealthier regions. Also a standard base map shows physical distance from one place to the other but doesn't explain anything about mental distance or the accessibility of those places. Therefore treemaps provide an interesting way of combining the possibility to present data in the shape of the country as well as in a different way.
The Kyrgyzstan Treemap is a great step forward to inform the interested parties about migration and unemployment not just at the oblast level, but also at their community/village level. One can easily identify which community has the highest level of migration (by ethnicity) and answer the question of "who is migrating" once you add other variables such as age, gender, etc.. This visualization tool helps to present large amounts of information in a simple and interactive manner, thus encouraging the user to explore their data and discover hidden relations and patterns.

7 Nepal Map for Labour & Student Migration

7.1 Context

Our objective was to design an interactive map to explore, compare and present aspects of Nepali labour and student out-migration. While labour migration has a long history in Nepal student mobility is more recent. In Nepal, so far very little attention has been paid to the mobility of students in general and also in comparison to labour migrants.

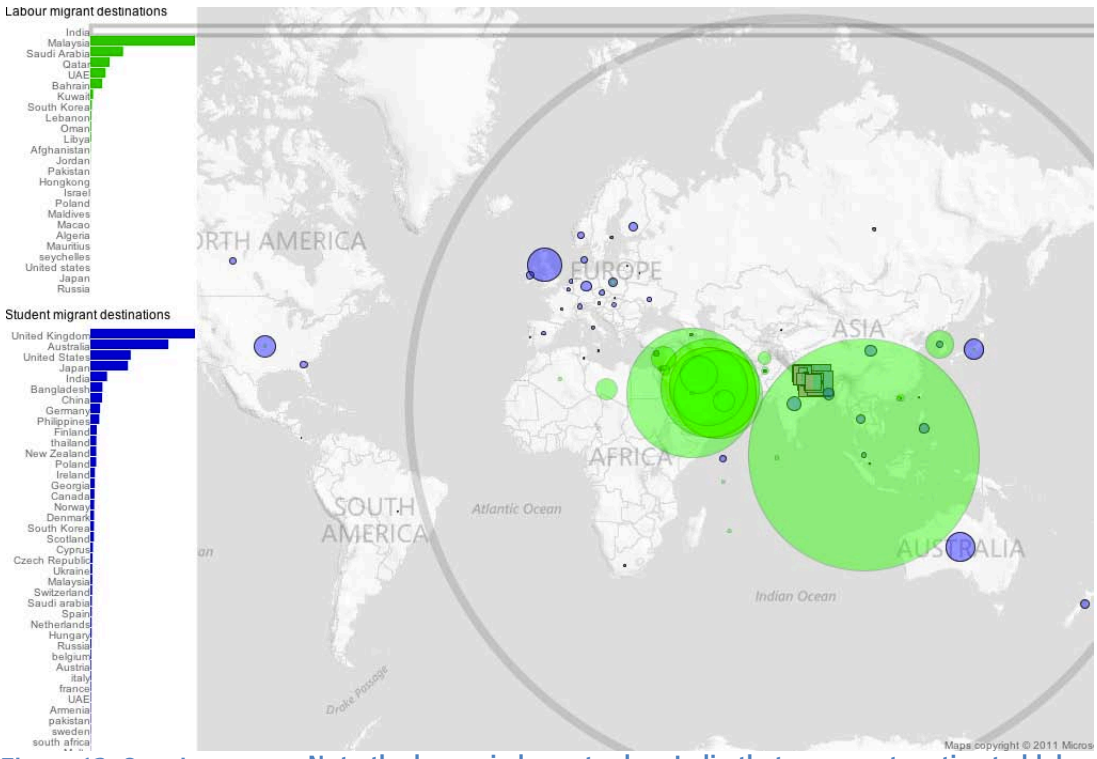


Figure 12: Opening screen. Note the large circle centred on India that represents estimated labour migration to India. The squares correspond to Nepali census data, to which one needs to zoom to resolve.

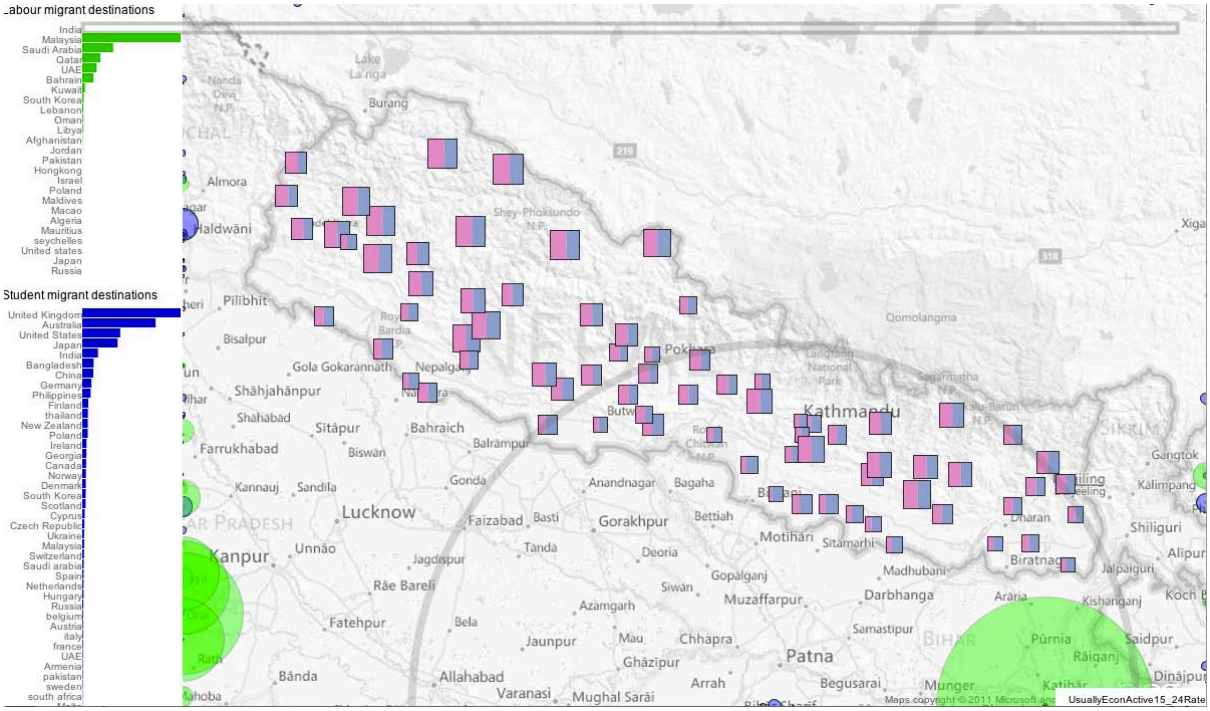
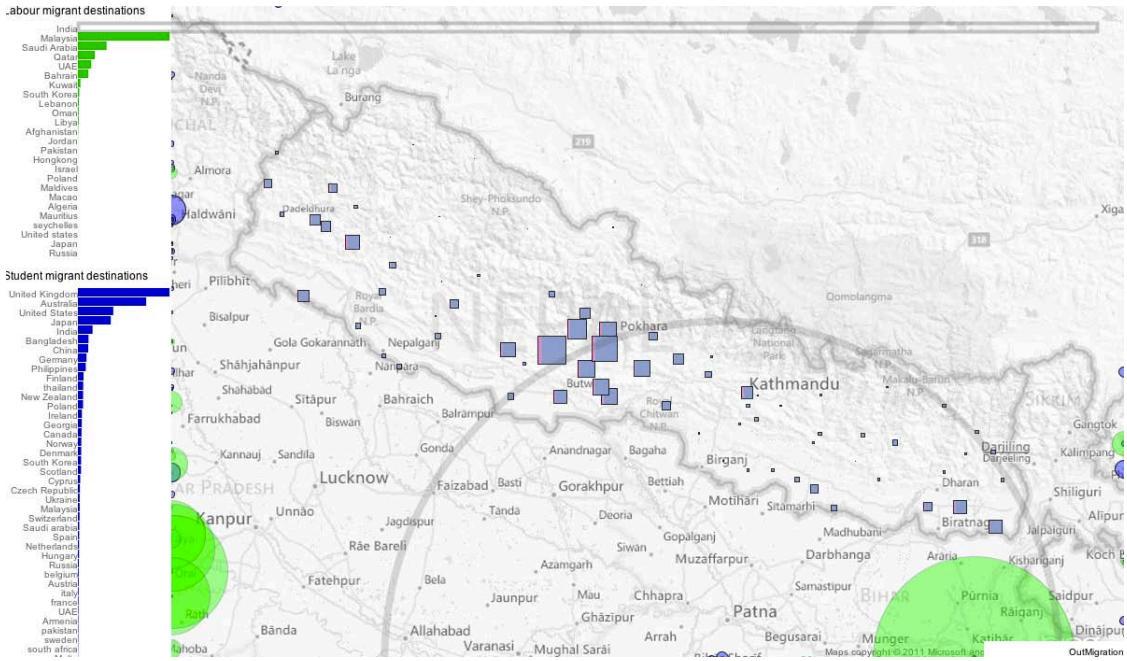
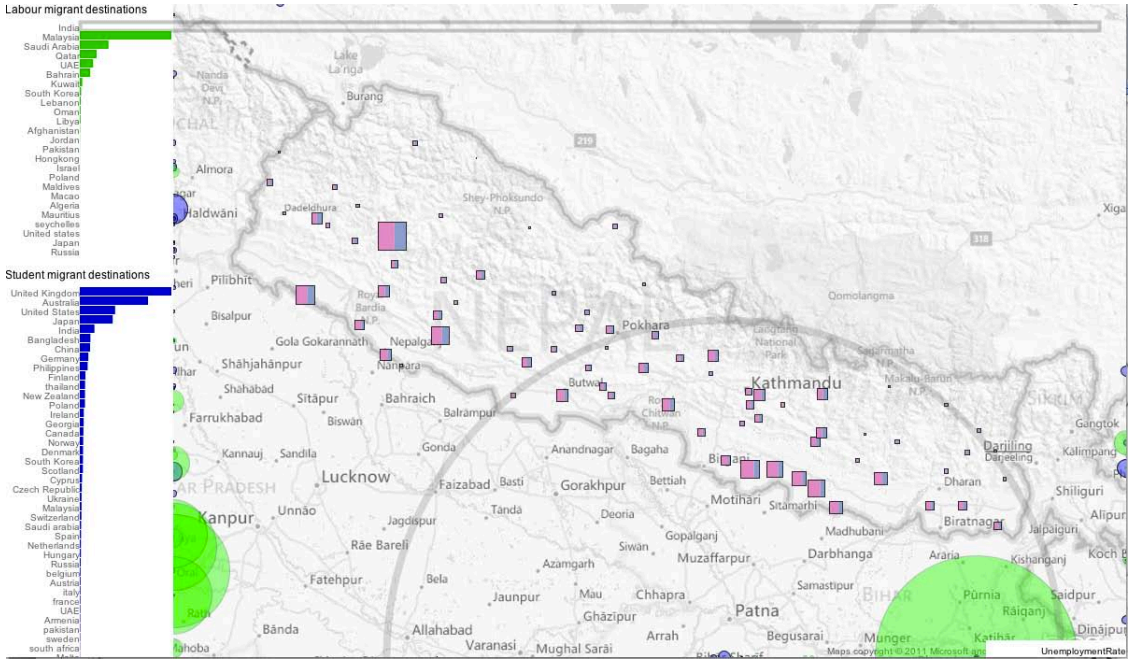


Figure 13: Zoomed in on Nepal. Notice that the migration circles are visible at the edge of the screen in the geographical direction of the country (can be identified with a tooltip). Squares are sized by the usually employed population proportion at region level. The gender split is shown (female: pink/left; male: blue/right).





7.2 Methods

Data

Nepali census data were accessible through a customised interface, which imposed some limitations on our access to it. We also had some difficulties in determining which years the different datasets were collected.

Labour migration data were obtained from the Nepali Ministry of Labour and Transport Management. Labour migration to India was not included because there is controversy with the Nepal – India migration data. Nepal-India has an open border where migrants are not recorded. Therefore estimates of total numbers vary. We estimated a value of 1,636,527

Nepali migrants in India, obtained by taking the total abroad population from the census and subtracting all the labour/student numbers to other countries from that. This is 85% of the Nepali migration. These are reasonably close to a 2001 Nepal Census estimate (CBS, 2001)) that labour migration to India was 79% of all Nepali migration. Student migration data were obtained from the Nepali Ministry of Education, based on the number of "no objection" letters issued, which students have to obtain before leaving Nepal. Since these rely on students actively registering with the ministry before migrating, we expect these to be underestimates.

Visualisation method: Interactive map

Figure 12 shows the zoomable and interactive map that we designed to compile the relevant information we had into one place.
A zoomable map with base mapping from Bing was used. This is a familiar interface to many, and allowed us to present information at two different scales: global (the countries to which people migrated) and national (census data for different regions of Nepal).
Out-migration was depicted as circles centred on destination country whose areas were proportional to the number of people who migrated. The circles are translucent so they do not completely obscure other data and the boundaries are drawn over the top so that all circles are visible. Green depicts labour migration and blue depicts student migration. It is clear that labour migration dominates and tooltip allow details on demand to be obtained. The bar charts (scaled independently for labour and student migration) show that these two types of migrations are prevalent for different countries.
We had an interesting discussion about what to do with our estimated India labour migration, which applies more widely to these type of data. We did not have high confidence in our estimate and it was derived differently to the other values, but we thought it was important to show how it dwarfed other migration. This dwarfing affect was problematic for designing the map as it obscures everything else. Our solution was to use a different visual encoding to indicate that the value had been obtained differently from the other data. We made it transparent so that it did not obscure and can an option to remove from the display.

Census data are displayed as proportionally-sized symbols positioned at the central points of the region areas. It is necessary to zoom the map to resolve these, as shown in Figure 13. Migration destination countries remain on the periphery of the screen in order for these to be visible, even when considering data at a national scale.
Where gender information is available, the proportional symbols are split vertically with female on the left and male on the right. The user can switch to a range of relevant population characteristics from the census. These are: population, Gender Empowerment Measure, Gender Development Index, Human Development Index, % literate, % usually employed, % unemployment, % unemployment between 15 and 24, % usually economically active, % usually economically active between 15 and 24, % out-migration, % student out-migration and the population growth rate.

7.3 Content

Interpretation

This interactive map visualized more clearly the differences in migration patterns between international migration for foreign employment and migration for education. For example, in Figure 14 (above) it is easier for the audience to understand that the main destination choice for students (blue circle) is the UK while for labour migrants it is (green circle) is India. A benefit of the map is that it summarizes the data by conveying the message of who goes where and in what proportion. For example all the destination countries, separated for labour

migration and student migration and the size of migrants to each country is available on a single map. This puts the researcher in an easier position to analyse the data because it provides an overview of the whole dataset.

Limitations

This custom-designed tool is limited in the sense that it is only applicable to this data. The tool was designed and built over a couple of days. So it represents a design with some interesting design features, which we think could be applied in compiling other similar migration data. As with all visualisations we have to take into consideration the limitations of the provided statistical data itself.
A possibility for further research would be to incorporate qualitative datasets. This incorporation would add more detailed information to the map, thus overcoming the limitations. Qualitative datasets could include accounts from the interviews like feelings, reflections and emotions that are important for migration but cannot be quantified. Besides this, we would also like to add qualitative data that are methodologically relevant like descriptions of how each data value was derived and interviews, photographs and other multimedia to help personalise some of these migration stories.

Added value

This interactive map allowed migration-related data to be explored at two different scales: at a global scale (international migration) and at national scale (Nepali population) and allows us to compare different types of migration on one map.

8 Chad Map

8.1 Context

The Global Polio Eradication Initiative (GPEI) – the funders of this project – has asked for mapping the sites for best reach of populations most vulnerable to exclusion of polio vaccination in Chad – where vulnerable populations to exclusion to governmental vaccination campaigns can be best reached. The most vulnerable populations are internal refugees and highly mobile pastoralists (and, even after nearly 15 years of research with several PhDs at the Swiss Tropical and Public Health Institute, TPH, there are still a lot of knowledge gaps). Indeed, researchers of TPH have argued that such a map is not possible – exactly because they are vulnerable due to changing migration routes and large seasonal variations or – in the case of newly returned refugees – of unpredicted re-population of villages (where there are no services left when they return).

8.2 Methods & Content

In the first 4 months of the project we have reviewed monthly polio vaccination reports and undertaken participatory mapping of pastoralist movements. More participatory mapping is foreseen (for pastoralists and newly returning refugees).

The researchers have reviewed available documents and their usefulness to use data as layers in a map indicating 'hot spots' of polio poor vaccination coverage and transhumance routes of mobile pastoralists. The map (or maps) should particularly indicate the most appropriate locations to launch vaccination campaigns among the hard-to-reach populations.

We have combined the 2009 census data with the monthly polio (independent) monitoring reports from January – October 2011 (the most recent available reports). In the regions with surveillance in a given month (n=107), high numbers (a total of 333'895 during indoor and 150'092 children during outdoor in the 10 months) and proportions of children have been surveyed (a median of 4.3% of all children). No clear pattern for the regions is visible when mapping the proportions of non-vaccinated children (combined in- and outdoor sampling) per month, which raises the question if the sampling was randomised, but also reflects the previous vaccination activities (Figure 1). Note that the proportions of un-vaccinated children in the 'outdoor' sample are higher in 16 of the 18 regions than the 'indoor' sample (11.5% vs. 7.9%, $p<0.001$).

Figure 14: Proportions of non-vaccinated children found during monthly surveys between January and October 2011. No survey took place in the white regions. The categorization of non-coverage is according to quartiles

The livestock census 'Recensement général de l'élevage et de l'agriculture (RGEA) – Rapport d'analyse des résultats du recensement pilote (volet élevage), 2007, of the Ministry of Livestock Production, was an interesting source regarding livestock movements (and accordingly of people) in the country. Figure 14 and Figure 15 show the destinations and origin of transhumant and nomadic livestock, respectively.

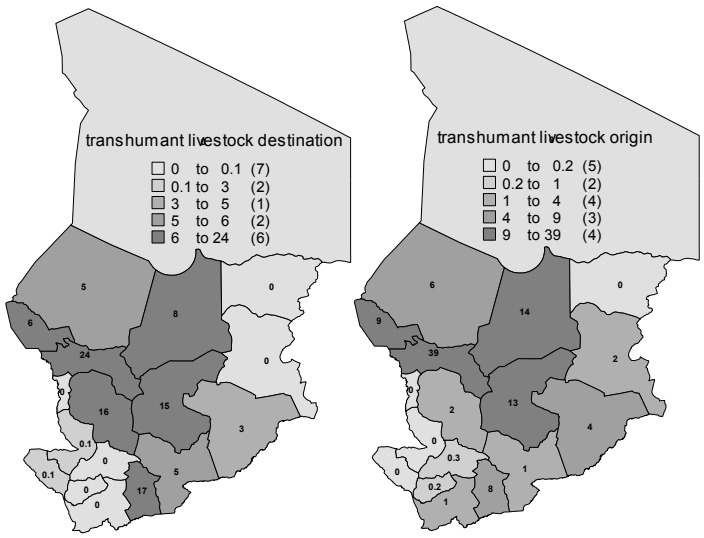


Figure 15: Proportional in- and out- migration of transhuman livestock within Chad (based on numbers found in the pilot livestock census)

Most animal movements are in the central regions, with the exception of the Fulani routes in the South (connecting to the Central African Republic). Our goal is to have a more detailed map that can be used for planning. The only existing map we have found is of the Direction of Water and Sewage, 2002 (Figure 16).

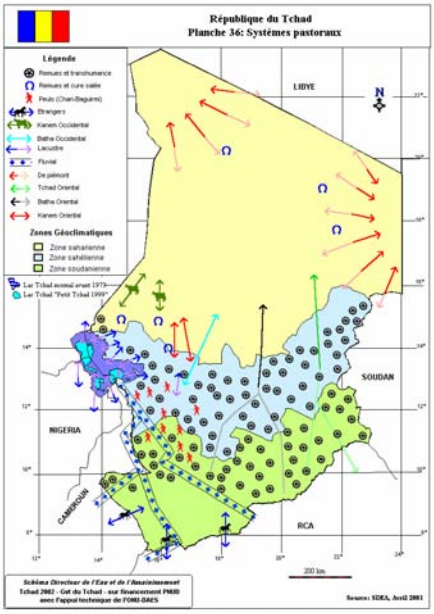


Figure 16: Map of the Ministry of Water and Sewage showing main movement directions and movement points

Since vaccination of mobile pastoralists is easiest done in zones of concentrations, we have asked all interviewees to sketch on the maps their knowledge on routes and zones of concentration for the 3 main ethnic groups (Figure 17 shows examples for all Chad and East Central Chad). Different colours were used for the ethnic groups.

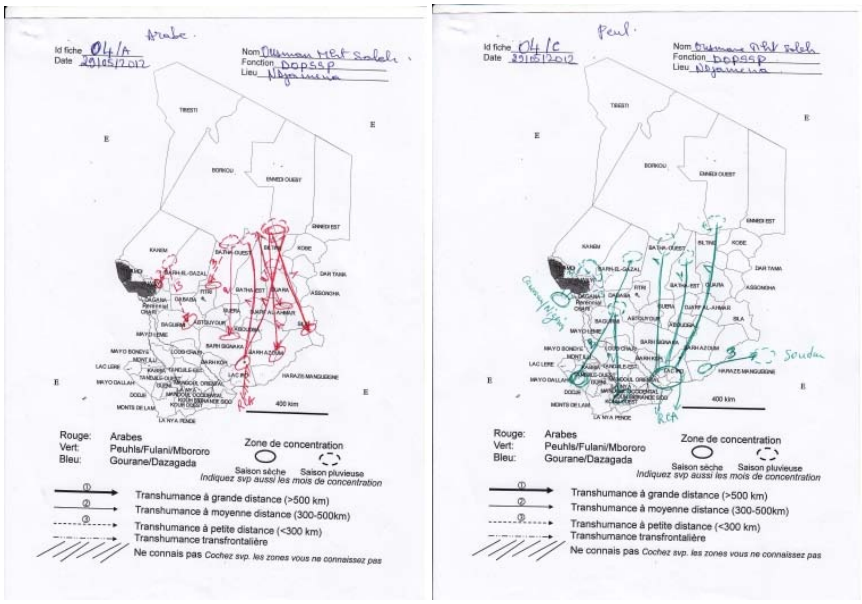


Figure 17: Examples of contributions for interviewees regarding transhumance routes and zones of concentration

The maps can be imported in MapInfo (Figure 18) and the layers summarised as major routes and zones. Research on bringing together the information of different sources to produce maps that are useful for the planning of vaccination campaigns is ongoing.

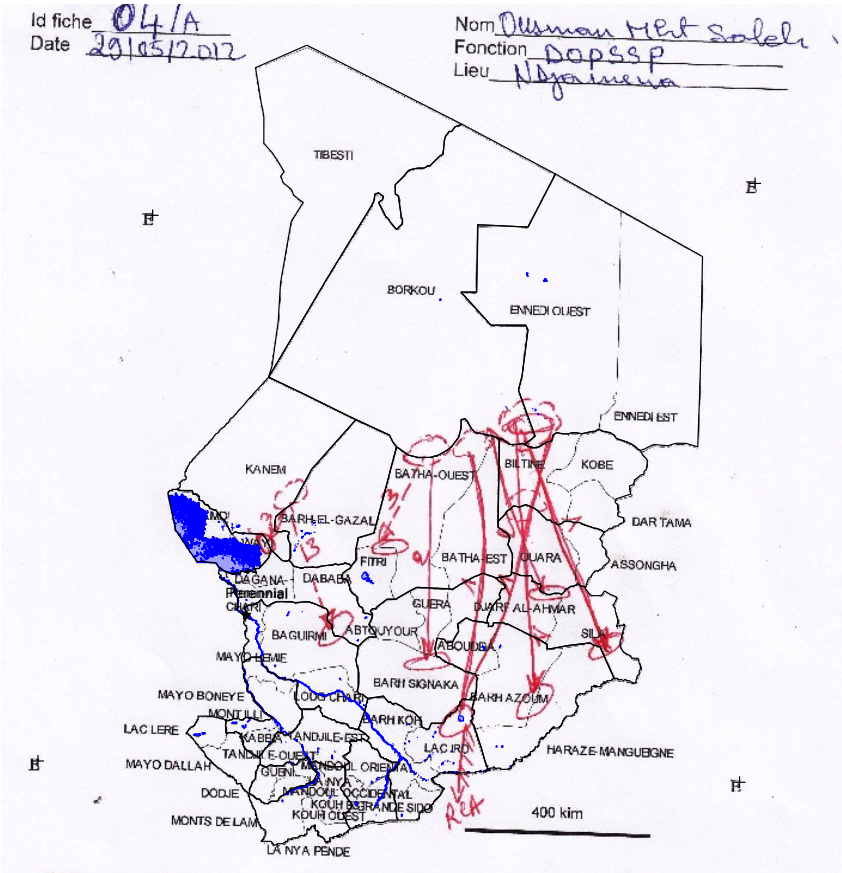


Figure 18: Interviewee's map imported and geo-registered to MapInfo

All maps that each TPH researcher produce in these highly mobile populations can hardly be validated. Indeed, researchers emphasise in any communication with GPEI that resource people (and we give a long list of who these could be for the two populations) would know the whereabouts of the populations at a given time. This exchange is essential – it cannot be captured on a map. The goal of reaching vulnerable populations each year must remain the goal – and not nice maps.

Limitations

Mapping highly mobile populations shows us the limitations of maps. This map is static and does not show any variation between days, weeks, months, years and seasons. Thus we have to be careful not to assume that by using this map we have an exact knowledge about the location of those people at a certain time. It is important to emphasize this limitation and remind users that a map is only a snapshot. In the daily communication with policy makers, for example, we experience the "power of maps and images", where people tend to stick to maps and overemphasize what they see. Therefore we have to be careful in deciding at what point it is applicable to use maps or not.

Added Value

Despite the limitations, a map remains a strong tool to inform and, if intended, convince policy makers and external readership about research results or gaps. However, the TPHs experience is that many maps and visualisations have been overinterpreted and used in the wrong way. In countries where a lot of well-validated data exist, visualisations might be applicable, although interpretation has to be done with care. In regions where there is hardly any data, we have to

question how applicable it is to visualize this little data and how dangerous it can be when users rely solely on the visualization provided. For the field of public health this can cause more damage than good and it is much more important to invest in training people to generate very basic and valid data rather than visualising the little data we have.

Links for tools and data

http://webgis.wr.usgs.gov/globalgis/
http://www.esri.com/data/free-data/index.html
http://wagda.lib.washington.edu/data/geography/world/
http://www.diva-gis.org/Data
https://gistdata.itos.uga.edu/
http://www.evl.uic.edu/pape/data/WDB/
http://geocommons.com/
http://geodata.tufts.edu/
http://openstreetmapdata.com/data
http://www.vdstech.com/map_data_world.htm
http://www.geonames.org/
http://www.princeton.edu/~geolib/gis/index.html

Workshop Website with Documentation:

http://www.geo.uzh.ch/microsite/MigrationVisualisation

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