Exploratory Analysis Tool For International Aid Data

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***Abstract*— In this paper we present a visualization tool to help understand why international aid is given and if the aid has an effect on countries' development. In order to understand the causes and effects of the aid disbursements we correlate aid data with World Bank indicator data.**

Index term— Aid data, World Bank Indicators, Information Visualization, Paired Pie Chart.

I. INTRODUCTION

"In international relations, aid (also known as international aid, overseas aid, or foreign aid) is – from the perspective of governments – a voluntary transfer of resources from one country to another." [1]

Although the above definition limited to transfers from one country to another, we can extend it to include organizations like World Bank, International Money Fund and many others, who're trying to help countries' to develop further and making the world a better place.

Despite the common sense, the aid donations are not solely given because aid-receiving countries need them. As stated later in article [1] regarding definitions of international aid "Both definitions employ the concept that benefit to the people of the receiving country must be one but not necessarily the only objective." Furthermore, studies like Alesina & Dollar, show there is "considerable evidence that the direction of foreign aid is dictated by political and strategic considerations, much more than by the economic needs and policy performance of the recipients" [2]

Aid Data Research Consortium [3] is a group of scholars conducting research on increasing efficiency of international aid practices. One of the consortium's missions is to gather all international aid data, and make it accessible by other researchers and scholars. However, by looking at the raw data itself, as a non-expert in the field, it's really hard to figure out to answer or generate questions like "Does aid disbursements follow some patterns?", "Why countries receive aid at some certain times?", "Is aid disbursements addressed properly by the donor countries or used effectively by its recipients?". By solely looking at the numbers and figures there's no way to make conclusions out of it, as for example $75M health care aid might be a lot for well developed countries whereas that money becomes insignificant to solve issues in Africa.

Unfortunately there's predefined mathematical formulas or algorithms to answer questions listed above. In this paper we present a tool for people (domain experts as well as any regular person) to arise questions regarding aid disbursements and find interesting pattern, which may lead increase in aid effectiveness. We correlate international aid data with World Bank indicators to understand international aid better. Though, the user should be aware of the fact that not every abnormality in the disbursements concludes to an interesting story. However, our initial testing proved extracting some common facts through the tool is possible, and with a deeper understanding on the issue, there would be more stories to tell.

II. DATA

A. *Aid Data*

As descried in earlier, Aid Data [4] is published by AidData Research Consortium to initiate researchers to work with international aid, and help aid practitioners. As we're not interested with the details of individual disbursements in scope of this project we use the 'thin' dataset provided in the website. The dataset contains information about every single aid transfer from 1940 to 2013. The details of each row contain the unique aiddata_id (to map from more extended datasets), year of transfer, the donor and recipients, amount of commitment and purpose name & purpose code to identify the cause of the aid, as shown below.

1168305 rows

Show as: rows records Show: 5 10 25 50 rows

All	aiddata_id	year	donor	recipient	commitment_ar	coalesced_purp	coalesced_purpose_name
1.	21235774	2004	Belgium	El Salvador	315565	92010	Support to national ngos
2.	94726192	2010	United Kingdom	Guatemala	151206	72010	Emergency/distress relief
3.	12807634	1999	Sweden	Zambia	125305	15150	Strengthening civil society
4.	14582630	2000	Sweden	Bilateral, unspecified	49752.3	15150	Strengthening civil society
5.	36695544	2008	Switzerland	Mauritania	370070	72040	Emergency food aid
6.	13273427	1999	Japan	Indonesia	1464710	72010	Material relief assistance and services
7.	29928104	2006	United States	Cambodia	955413	15250	Land mine clearance
8.	28222473	2006	Netherlands	Suriname	1449360	72010	Material relief assistance and services
9.	12191891	1998	Australia	Indonesia	103323	24040	Informal/semi-formal fin. intermed.
10.	21570910	2004	Germany	Peru	392065	43040	Rural development

Fig. 1. Original Aid Data (Thin version)

As seen on the above table, the dataset contains, more than 1 million aid transitions. The file itself was larger than 90MB, where it wasn't possible to create a visualization that could seamlessly load to the tool. So we applied data manipulations and shrank the data size to 1350 (6 rows per country).

1300 rows Extensions: Freebase CKAN

Show as: rows records Show: 5 10 25 50 rows « first ‹ previous 1 - 10 next › last »

All	recipient	country_code	purpose	total	average_yearly	average_disbur	[1960-2011]
1.	Afghanistan	AFG	Education	2289268951	44024403	65407684	[,,,,24434800,,,,,,,,,188260,3633090,40635,21123900,16131555,7316764,53321800,,,,
2.	Afghanistan	AFG	Agriculture	3685255373	70870296	102368205	[,,,,,,,,,1048140,66483461,30551263,1344960,57860650,66410414,73467379,1753279
3.	Afghanistan	AFG	Water	889859025	17112674	38689523	[,,,,,,,,,,,,,4195170,,34490923,27358877,15369700,55436710,797924,,,,,522322,,,,,,,,,,,
4.	Afghanistan	AFG	Health	2516696160	48398003	83889872	[,,,,,,,,,,,,,,,217141,,10228081,6267801,,,,,,2089420,,13432,6095830,17242798,2262390
5.	Afghanistan	AFG	Law&Justice	14218679941	273436153	568747198	[,,,,,,,,,,,,,,,,,,,776598,,,,,,966629,16371610,4908350,1914500,,11244830,,5742468,108
6.	Afghanistan	AFG	All	23599759449	453841528	575603889	[,,,,24434800,,,,,1048140,66483461,30551263,1344960,62244080,70043504,1082160
7.	Albania	ALB	Education	663700207	12763466	33185010	[,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,6668,11116238,158962,14974215,10467027,2650051,2091728,57
8.	Albania	ALB	Health	386778315	7438045	19338916	[,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,180411,9379620,7169200,28202350,5339506,5514742,1421395,3
9.	Albania	ALB	Agriculture	597252203	11485619	31434326	[,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,6637257,39560160,70421276,44976251,20274036,10764948,10
10.	Albania	ALB	Law&Justice	1411543775	27145073	74291778	[,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,585148,43355866,6519792,27058862,3814932,23139043,55659

Fig. 2. Aid data totals per purpose aggregated by country and year

Above table shows the initial result from data manipulations applied. We shortlisted the types of aid in our tool as agriculture, education, health, law/justice and water purposes. We identified purpose codes for each issue and aggregated those purpose codes to their mapped purposes. Here each column contains yearly aid disbursements, total aid, yearly average, and disbursement average per country per purpose.

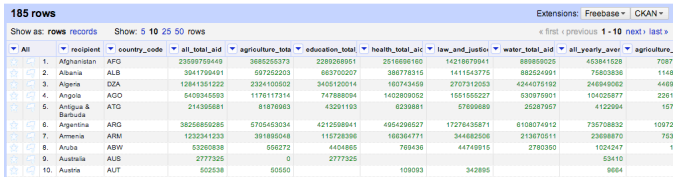

Fig. 3. Finalized Aid values for each purpose aggregated by country and year

Finally, we've merged all five + all purposes into a single row and finalized the modified Aid Data table.

B. *World Bank Indicators*

World Bank provides over 200 indicators for every country in the world, in order to evaluate their development on specific issues. They publish a separate dataset for each indicator containing information for each country as shown in below figure.

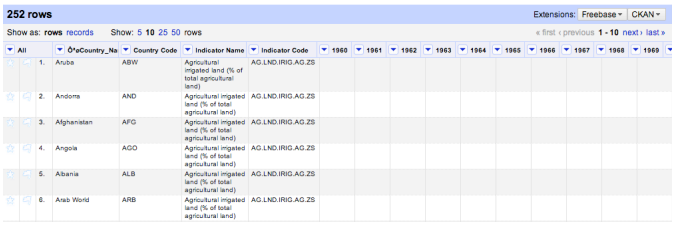

Fig. 4. Example World Bank Indicator dataset for Agricultural irrigated land (% of total agricultural land)

For our task we only needed one indicator for each aid purpose, which would reflect the overall changes for that purpose the best. This task was beyond our expertise as it required mapping a single indicator out of many which would generate the best result. We contacted many experts and scholars from Aid Data Research Consortium, various universities and independent research centers. Below are their recommended indicators mapped to their respective purposes.

Indicator Name	**World Bank Indicator Code**	**Corresponding Aid Data Purpose**
Agricultural irrigated land (% of total agricultural land)	AG.LND.IRIG.AG.ZS	Agriculture
Primary completion rate, total (% of relevant age group)	SE.PRM.CMPT.ZS	Education
Maternal mortality ratio (national estimate, per 100,000 live births)	SH.STA.MMRT.NE	Health
Informal payments to public officials (% of firms)	IC.FRM.CORR.ZS	Law & Justice
Improved water source (% of population with access)	SH.H2O.SAFE.ZS	Water
GDP (current US$)	NY.GDP.MKTP.CD	All Purpose Aid

Table. 1. Selected indicators and mapped purposes

After the mapping, we've generated a one giant World Bank indicators dataset and similar to the processes we've applied for aid dataset, we've created yearly indicator values and averages for each purpose per country as shown below.

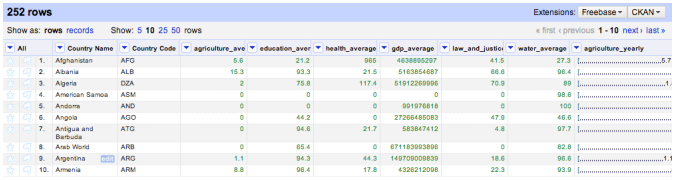

Fig. 5. Finalized World Bank Indicator data aggregated by year and merged indicators

C. *Master Dataset*

After completing data manipulations on both aid and World Bank indicators datasets, we joined two datasets by country names. Also we included country population data [6] to calculate statistics like aid per capita for each reason and convert indicators like GDP to GDP per capita. Further investigation of data also drove us to use per capita values instead of totals, as total aid amounts and values like GDP are highly related to countries population where it caused misinterpretations of data.

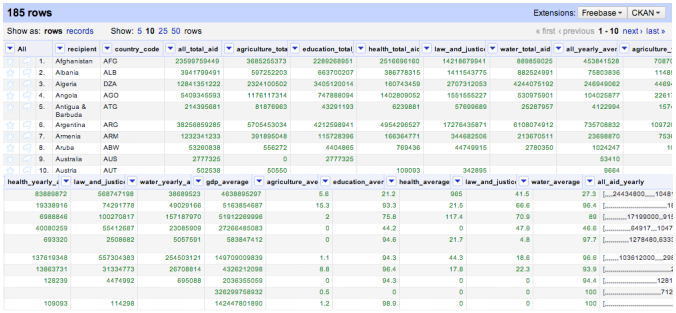

Fig. 6. Final Master dataset combining Aid Data & World Bank Indicators per country

III. Proposed Solution

After identifying the problem, and locating the data sources, we went through several stages during until finalization solution design. Our earliest inclination was to focusing on various indicators, and statistics within a country. A dashboard like idea similar to Fig. 7 was a natural and elegant implementation to this solution. Where we were thinking about finding interesting facts for per country and display them in fancy visualizations. Fig. 8 is a screenshot of our attempt towards this solution.

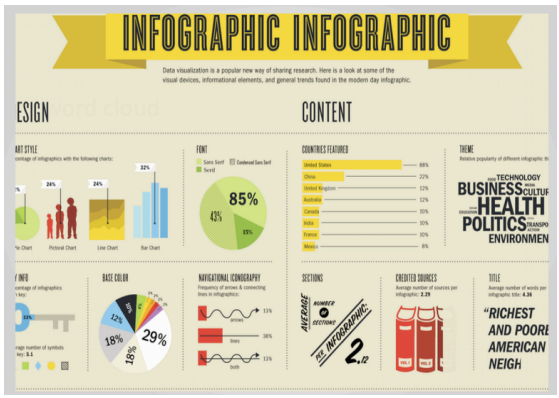

Fig. 7. Initial Infographic proposal idea

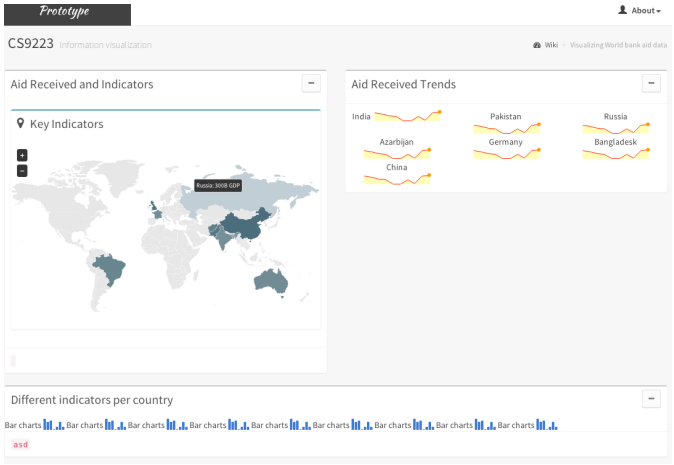

Fig. 8. Initial Implementation

Upon our initial work, we've realized this visualization would require users to know what they're looking for, or have pre-defined questions in their mind. However, this was not our goal to achieve. At this point, upon proper feedback and guidance from Prof. Enrico Bernini, we decided to revise our design and come up with a new design from scratch if needs to be. We've been advised from him to focus on different encoding techniques like glyph graphs to show interestingness of aid/world bank indicators correlation.

Below is a screenshot from our final design. Visual elements of this implementation are explained in the following sections.

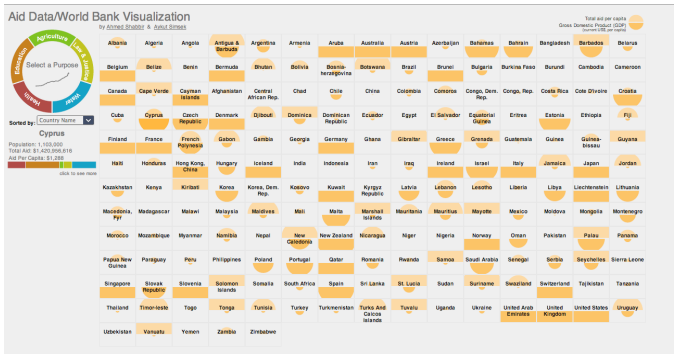

Fig. 9. Final Design

A. *Glyph Map*

The glyph map is the key element in comparing countries with each other and to see how well their indicators are doing in average and if they are receiving aid for their respective aid purposes.

"Glyphs are basically composite graphical objects where different geometric and visual attributes are used to encode multidimensional data structures in combination." InfoVis:wiki [7]

In this list, each box repsesents a country, containing two half circles. The upper half circle shows the received aid per capita per purpose, and the lower half showing the respective indicator value. With this representation it is easier to detect facts like which countries have the highest/lowest indicator values? and which ones receiving more/less aid?. Similarly, this enables user to arise questions like "Why some specific countries receive large amount of aid where it appears there are others in more need?" with a quick glance. With sorting function defined later in this paper, it becomes even easier to detect abnormatilities like above. An overflow of the circles causes them to appear as rectangular boxes in the visual, but this was a scaling decision we made to be able to show smaller values on the glyphs. You can see the complete circle by clicking on overflowing boxes.

Fig. 10. Glyph Map for Total Aid

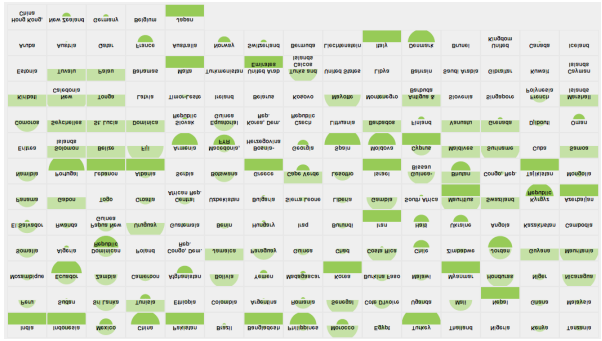

Fig. 11. Glyph Map for Agricultural Aid

Fig. 12. Glyph view for Health Aid

B. *Legends*

In the previous section we've explained the function of the circluar glyphs. Upon chaning the purposes the color, aid per capita values and indicators in glyphs also change. Below is the state of glyph legend for every purpose.

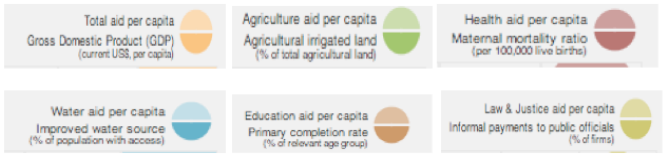

Fig. 13. Legends for each purpose indicator combination

C. *Sorting*

This common interaction elements enables us to sort the countries based on a specific index and enable faster recognition of abnormalities compared to other countries. You can sort the glyph map by Country Name (the default), Population, Aid Per Capita (for selected purpose), Indicator value (for selected purpose), total aid (all purposes) and Aid For Selected Reason (appears only when a purpose is selected).

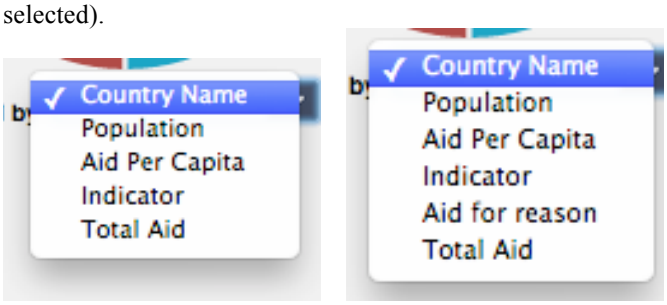

Fig. 14. Sorting through dropdown select

D. *Donut Selector*

The donut selector is our own implementation to enable user change view to different aid purposes. The selector contains the aid purposes on it's arcs, and a cicular area to containing the name and an icon of the selected purpose along with a sparkline of yearly world trend of selected purpose. We've designed this element to serve as both the selector and initiate color coding for each purpose. Initially the donut is filled with "Select a Purpose" message and showing the total aid receiving trend in the world.

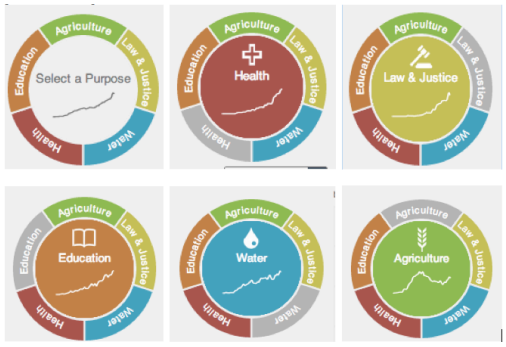

Fig. 15. Selecting purposes through donut selector for each purpose

E. *Infoboxes*

The infoboxes apper when user hovers glyph boxes. As it's not possible to infer exact values from the glyph itself, it helps user to understand the actual amount and indicator values. These boxes also contain a horizontal stacked bar to show how aid is distributed among different purposes within the country. For example in Fig. 16 we can see Health related aid is the main source of aid donations to Madagascar.

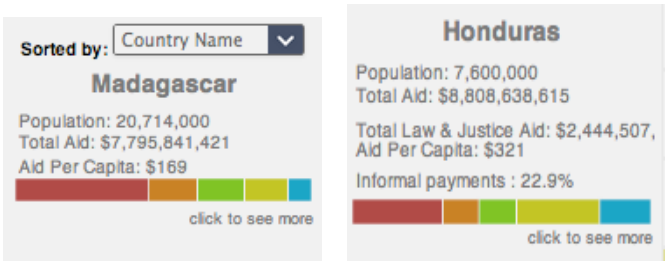

Fig. 16. Infoboxes appearing on mouseover

F. *Enlarged View & Paired Pie Chart*

In this tool, we're proudly designed our own visual element, the Paired Pie Chart, to compare spatial values over time with each other. The Paired Pie Chart contains values for two time series where the upper half time variable inreases, and lower half time variable decreases in clockwise direction. By doing so the values of the same year locates along the diameter of a circle. This enables user to easly compare the same yearly value. And along the same half circle, the thin line marks the average of the values on that half, so that the user can easily compare the increasing and decreasing trends over time.

When user clicks on one of the boxes, the box expands to a paired pie chart view, which contains a paired pie chart showing in country aid disbursments (on upper half) and indicator values (on lower half), also maintains the initial circular glpyh faded in the middle, so that the comparison between the countries is still possible. Also upon user hovering on each slice, representing a year, they can see the aid disbursments for that year and relavent indicator value highlighted. Also on mouseover actual values printed on screen for deeper understanding.

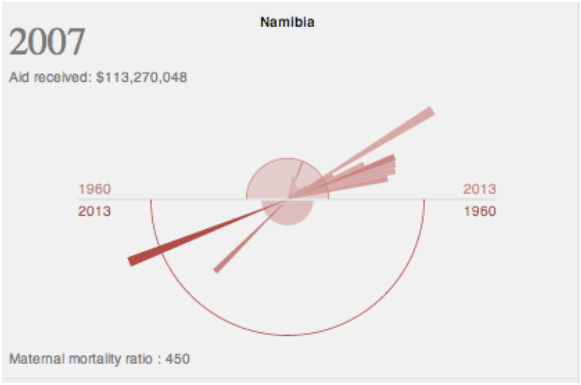

Fig. 17. Enlarged view and paired pie chart

IV. Results

Using our tool, we were able to extract some of the common stories we've already know from the visualization.

A. General Trends

By common sense we'd be able to guess the poorer countries would receive more help than the rich ones. Well, when we sorted our data by aid per capita, we can see the boxes with overflowing upper halves have almost no circles at the bottom, which shows the countries receiving more aid per capita has less GDP per capita. Also in this mess of boxes we can still easily identify rich countries like Palau, Barbados etc. receiving a lot of aid despite they have fairly larger GDP per capita than similar aid receiving countries.

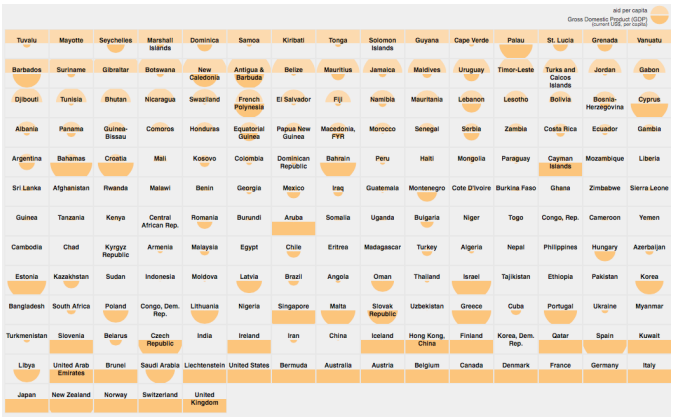

Fig. 18. Results showing general trend of aid disbursements is to help poorer countries

B. Aid Effectiveness

In Fig. 19, the total aid being effective in countries like Iraq, Afghanistan and Pakistan, where we can see a direct correlation between the total amount of aid they received and their GDP per capitals. This may conclude that the received aid has been used properly to increase countries wealth. Another interesting fact we can see from those graphs is, we're familiar with the wars in Afghanistan [9] and Iraq [8], and interestingly we can see those countries starting receiving aid after their wars break out on the upper halves, where aid disbursements start increasing at exactly same time as the beginning of war.

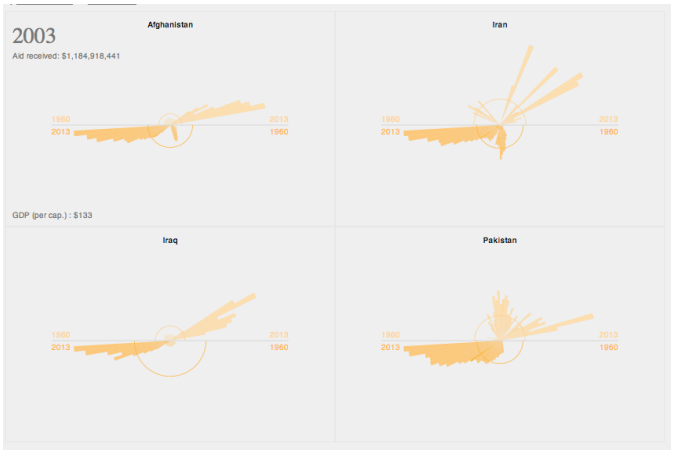

Fig. 19. Results showing the correlation between total aid and countries' GDP

Also in below figure, we see the agricultural aid and indicator comparisons. We can see Pakistan have received a lot of agricultural aid earlier in 1950, although we don't have indicator values before 1980s for this country, we can see the country developed a well agricultural system early and currently ranking #1 in agricultural indicators.

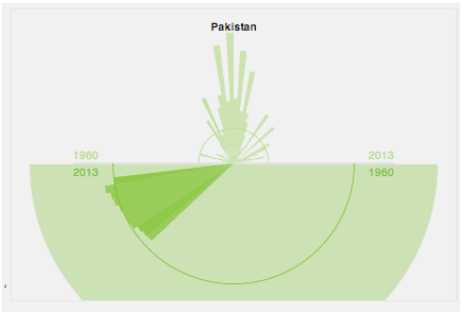

Fig. 20. Pakistan's agricultural aid and agricultural indicators

C. Aid disbursment analysis

In the previous section we've talked about aid disbursments upon wars in Afghanistan and Iraq, similarly if we dig deeper in these countries, from the horizontal stack that most of those disbursments are going to law & justice purposes, which is again an expected result considering stabilizing the order in a war zone is the primary objective. We believe this is a solid finding as in similar trending countries like Pakistan we do not see the same pattern.

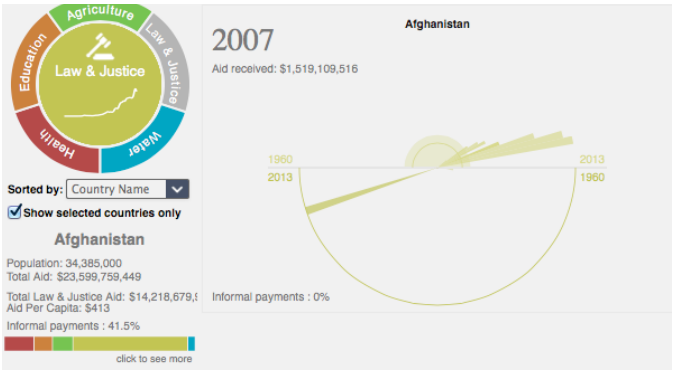

Fig. 21. Afghanistan's Law Justice Aid vs. Indicators

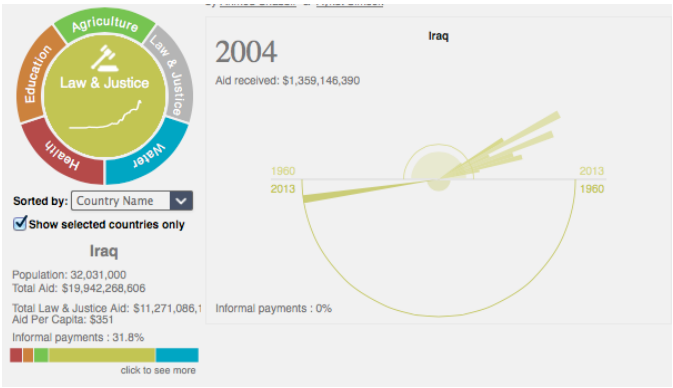

Fig. 22. Iraq's Law&Justice Aid vs. Indicators

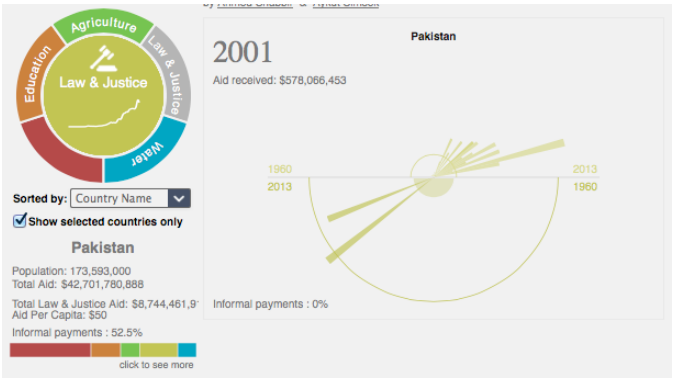

Fig. 23. Pakistan's Law&Justice Aid vs. Indicators

V. Future Work

Throughout the results section we've tried to interpret popular world events from the results. A similar trend can be seen in Zimbabwe, where we can see a sudden drop in GDP in 2008 and aid kicking in in 2009, then GDP saddling back. We investigated this change and found out about the economical crisis in Zimbabwe in 2008 [10]. This was an interesting surprise to find. However, for the rest of the data we believe there are many other interesting stories that we can better assess the changes in aid disbursements and indicator values. For that cause, we're willing to combine this visualization with major world and country events so that we wouldn't have to be experts in world history and the visualization itself would bring up the important events like political changes, disasters etc. so that we can easily connect the changes with events.

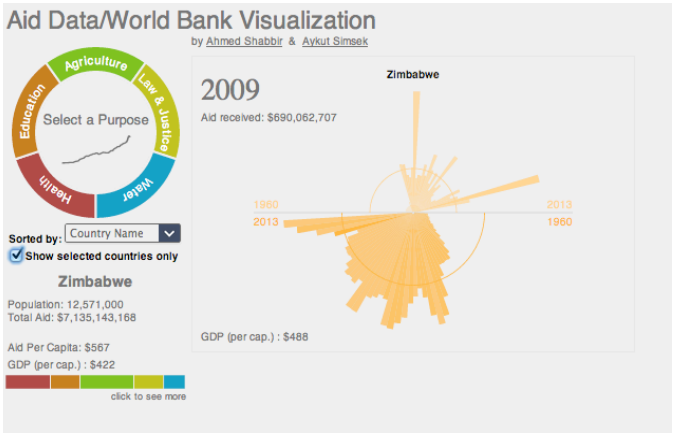

Fig. 24. Zimbabwe economic crisis in 2008

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[1] "Aid." Wikipedia. Wikimedia Foundation, 13 May 2014. Web. 15 May 2014. <http://en.wikipedia.org/wiki/Aid>.

[2] Alexia, A. and D. Dollar (2000). "Who Gives Foreign Aid to Whom and Why?" Journal of Economic Growth 5(1): 33-63.

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