

# Urban Development

# Data Visualization

## HCI Course Project

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## Project Overview

Purpose of the project is to provide a user friendly and interactive visualization of world urban development over the past 5 decades. Based on the client's data set, application aims to provide visual representations in the form of multiple graphs and map for given set of dimensions/parameters. Apart from the visual perspective, the application would reduce the human effort in filtering and normalizing the data and offer easy, flexible automated visualizations. Web application would allow the user to visualize urban development parameters of a single country or compare different countries growth rate for the given data. Application shall also provide options to change the graphic colors on demand, print them directly and save as images in multiple formats on a local machine.

## Requirement Analysis

### *Proposal Presentation*

## Project Description

- Interactive Visualization project based on the historic urban development data of major world countries.
- Data handled from 1960 to 2014.
- Web application that allows user to visualize and compare the urban development parameters of countries:
  - Multiple urban development parameters of a single country.
  - Compare growth rate of multiple countries.
- Customizable graphics options for visually pleasing experience.

**Need for the Project:**

- To reduce human effort to comprehend required data from vast historical data set.
- To change visual representation on demand.
- To download/print a visual data without much effort.

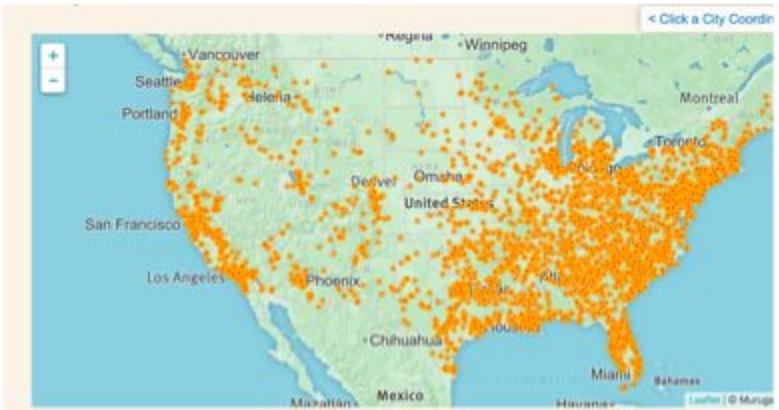
## Project Requirements

- **User**
  - Data Analyst interested in visualizing vast data in convenient way.
- **Data**
  - Client has agreed to provide data required for visualization in the form of csv files, which would be converted to JSON data.
- **Proposed System Features**
  - System shall support different visual representations of data: Graph, Bar chart, Pie chart, Map data.
  - System shall allow users to modify color of plotted visual diagram.
  - System shall allow user to download visual diagram as a PDF.
  - System shall save the user activity which allows user to view visual graphs/comparison results anytime.
  - System shall allow user to print visual graphic directly from webpage.
- **Challenges Involved**
  - To visualize multiple countries parameter on a graph/map on demand.
  - Make the visual representation interactive and provide additional information on hover.

# Summary

- **Project Goals**
  - Pre-process data: convert data to required format.
  - Visualize complex urban development data on demand.
  - Compare data for various countries/parameters.
  - Support multiple visualization: graph, charts, maps.
- **Technologies to be Used**
  - Relational DB
  - Visualization– d3.js, leaflet.js, openstreetmap
  - Web technology: html, css 3, jquery, AJAX
  - Programming Language: Java, Python

# Sample Code from Hw1



## Sample Code from Hw1

#### **Tools used:**

- Leaflet.js
  - Openstreet maps
  - HTML
  - CSS 3
  - jQuery

## Data and Task Taxonomy

**Data Type:**

## ➤ Tables:

- Historical data stored in Relational Table Database.
  - JSON objects converted from Table Data.

### **Tasks:**

#### ➤ Consume Existing Information:

- Use available data to project visualization more easy to comprehend.

#### ► Identify New Relations:

- How urban data parameters relates to economic development of a country.
  - Compare growth rate of different countries.

Data provided by client

## Use Cases

### Use case -1:

**Name:** Select parameter to view Urban Development for a single country.

**Actors:** User, System

**Initiator:** User

**Triggering Event:** User selects option to view urban development for a single country.

**Pre-Condition:** User has successfully logged on the webpage.

**Post-Condition:** A default graph will be plotted for selected parameter.

#### Events:

1. User selects a parameter of interest from a dropdown to see visualization for a country.
2. User then selects the country of interest from a dropdown.
3. User then clicks on a button to generate a visualization.
4. System catches these responses and generates a default visualization graph for the selection.

### Use case -2:

**Name:** Select parameter to compare urban development for multiple countries.

**Actors:** User, System

**Initiator:** User

**Triggering Event:** User selects option to view urban development for multiple countries.

**Pre-Condition:** User has successfully logged on the webpage.

**Post-Condition:** User is able to compare urban development parameter for multiple countries based on selection of parameter.

#### Events:

1. User opens the Application page and navigates to “Compare Countries Data”.
2. User selects a parameter of interest to see visualization for a country
3. User then selects multiple countries to compare data.
4. User clicks Compare button.
5. System shall display the visual comparison graph(s) based on the user selection for multiple countries urban development.

### Use case -3:

**Name:** Save visualized data as PDF

**Actors:** User, Database, System

**Initiator:** User

**Triggering Event:** User clicks “Save as PDF” button.

**Pre-Condition:** User generated any form of visual data from the application.

**Post-Condition:** User is able to save the visual data as a PDF document locally.

**Events:**

1. User views any generated visual data in application and clicks “Save as PDF” button.
2. System shall capture the visual data generated and converts into an image saved in a PDF file and saves this file locally.

**Use case -4:**

**Name:** Change representation of visual data

**Actors:** User, System

**Initiator:** User

**Triggering Event:** User wants to see visualization in different formats

**Pre-Condition:** User has successfully generated at-least one visualization graph.

**Post-Condition:** User is able to change the representation of visual data from one format to another.

**Events:**

1. User is in “A Country based Visualization” page and selects his/her choice of visualization.
2. System shall hide the current visual display and shows the new (converted) data representation as selected by user.

**Use case -5:**

**Name:** Interactive tooltips displaying additional information.

**Actors:** User, System

**Initiator:** User

**Triggering Event:** User hovers over the visualization graphs

**Pre-Condition:** User has successfully generated a visualization graph. .

**Post-Condition:** A tooltip occurs on the screen displaying additional details of the hovered content in the graph.

**Events:**

1. User hovers the mouse cursor on the graph element.
2. The system catches the response and shows a tooltip with additional details about the element.

**Use case -6:**

**Name:** Compare urban development for multiple countries on map.

**Actors:** User, System

**Initiator:** User

**Triggering Event:** User wants to compare urban development on a world map.

**Pre-Condition:** User has logged on the webpage.

**Post-Condition:** User is able to get detailed comparison of various countries in world map based on a selected parameter and a given year.

**Events:**

1. The User selects a year and the parameter for which he/she wants to compare development all around the world.
2. System catches this response and displays world map with trend all around the world for the specific year-parameter combination.

**Use case -7:**

**Name:** Compare urban development for multiple countries from map for multiple parameters.

**Actors:** User, System

**Initiator:** User

**Triggering Event:** User wants to compare urban development on a world map.

**Pre-Condition:** User has logged on the webpage.

**Post-Condition:** User is able to get detailed comparison of various countries in world map based on a selected parameter and a given year.

**Events:**

1. The User selects multiple countries from the map to compare.
2. System catches this response and generates a visual encoding to show trend in the development for 7 different parameters.

**Use case -8:**

**Name:** Motion Chart visualization of various urban development parameters

**Actors:** User, System

**Initiator:** User

**Triggering Event:** User wants to compare motion based visualization.

**Pre-Condition:** User has logged on the webpage.

**Post-Condition:** User is able to automatically generate motion based visualization for parameter combination.

**Events:**

1. System generates a visualization on preset parameter combination.
2. User selects his/her desired parameters. The user can also select countries to trace their development trend.
3. The system caught these responses and simultaneously changes the graph representation and the points plotted on the graph.
4. The user selects the play button.
5. The system catches this response and then provides a smooth motion visualization for user to analyze trend in development.

**Use case -9:**

**Name:** On demand color change and scale change (linear or logarithmic) for motion chart visualization.

**Actors:** User, System

**Initiator:** User

**Triggering Event:** User wants to compare motion based visualization and change the color or scale of graph.

**Pre-Condition:** User has generated a graphic representation in motion based charts.

**Post-Condition:** User is able to easily change the color or the scale of graph generated.

**Events:**

1. User changes the scale of graphic representation from Linear to Logarithmic.
2. System shall immediately redraw the graph based on the new scale.
3. User shall change the color of graph for urban development trends.
4. System shall plot the graph with requested color codes.

# Specifications

## *Disclaimer*

The Specifications are complete to the best of my knowledge. Should there be anything missing, please let us know so that we can incorporate the requirement in the product.

## *Author*

Murugappan Nachiappan and Kartikey Pradhan.

## *Goals and Target*

### **Low level Target:**

#### **Visualize Trend in Urban Development for a Country:**

Mr. Anderson wanted to see trend in urban development for the country United Arab Emirates. So he logged into website and selected the country name as United Arab Emirates. Doing so, he got a list of things from which he can select one item of interest and also selected a year from which he wanted to see urban development trend and click GO! After this, Mr. Anderson was surprised! He saw understandable graphs that showed him trends in urban development.

#### **On Demand Visualization Change:**

Mr. Anderson generated a visualization graph by giving some details but his wife wants to change the graph representation. So Mr. Anderson selects some other graph representation from a list and instantly system shows up the same data represented in new chart representation selected.

#### **Save Visual Data:**

Mr. Anderson now wants to save these graphs on his system as he wants to mail them to his clients. So he clicked the save as Image button. Instantly, an image file of the visualization is saved locally.

#### **Non-Functional Requirements:**

1. **Performance:** System should not take more than 5 seconds to generate visualization.
2. **Usability:** Application must be intuitive for new users and provide visual feedback such as status for all operations.

### **Mid level Target:**

#### **Compare Multiple Countries Urban Development:**

Ms. Jayne has an assignment to compare urban development trends on urban poverty gap at national poverty lines for multiple countries. So she opens the webpage and selects “compare urban development around the world!”. She selects various countries and urban poverty gap at national poverty lines (%) from a list and clicks Compare! Jayne was happy to see comparison results (line chart, or stacked bar chart) and uses them in his assignment which gets him good marks.

### **Map Based Visualization:**

Ms. Jayne wanted to compare the urban development trend for some countries in African sub-continent for year 2010 but she don't exactly remember all country names. So she opens “Map Based Visualization” tab and selects a year and parameter, water sanitation facility. Now, she is able to get the world map view on development trend and she zooms in on Africa and see the development trend.

She now wants to compare development trend of countries of interest. She knows that she can achieve if by going to multi country visualization tab, but she wants to see the comparison alongside graph so that she can take a print of both together and use it in her study. So she selects all the countries of interest from the map and a graph comparing all the countries of her desire appears and she was glad that with this detail on demand feature, she saved a lot of time and introduced this website in her class for other students to benefit from.

### **Motion Based Visualization trends:**

Ms. Jayne want to compare all countries on the basis of two parameter selections. But she is not in mood to study any static graph anymore. So she opens the motion visualization tab on the website. She then sets the parameters that she wants to compare for all countries and then click on the play button. She also selects trace option for some of the countries so that those countries can form a continuous structure while other remain standalone.

### **Non-Functional Requirements:**

1. **Look and Feel:** Visualization transitions for multiple countries comparison should be smooth.
2. **Performance:** System shall not take more than 5 seconds to generate a visualization transitions.
3. **Usability:** While loading visualizations, system shall provide a status feedback to user.

### **High level Target:**

#### **Additional Details of Visualization:**

Mr. Bob has successfully visualized the urban population water sanitation facility across the globe on a Map view. But he also wants to see the details about the % of urban population, population in the largest city and improvement in water with access to sanitation facilities for a country. So he hovers his mouse a country, selects multiple countries from the map and sees a tooltip on hovering mouse on the graph with details of all countries from all the graphs.

#### **Technical Notes:**

**Tooltip:** It is a common graphical user interface element which generally appears as a small ‘hover box’ containing some information about the element on which the mouse pointer is hovered.

#### **Non-Functional Requirements:**

1. **Look and Feel:** Available color schemes should minimize the visual clutter and user shall be able to manually slide through the years to view a particular trend. Visualization transitions should be smooth and the user should be able to control the speed of transition.
2. **Performance:** When user hovers a visualization area, the response time for a tooltip should be instant without any lag.

#### **Full bells and whistles target:**

##### **Estimating Future Trends in Urban development:**

Ms. Avantika is involved in a research to use data from historic urban development for a country and extrapolate these finding to estimate the future trends and resources required for effective urban planning. She clicks on button ‘Future Development Trends’ and multiple graphs are plotted that shows future development trends for next five years based on selected parameters,

##### **Visualize data with Compatible Data File:**

Ms. Avantika wants to add in her research about trend changes in traffic with development trend changes in a country. So she uploads a file, having predefined set of columns, on the application and clicks on visualization button to see multiple graphs for changes in traffic with development.

##### **Email Visualized Data to Friend:**

Ms. Avantika has created a visual representation of data in the website and she wanted to mail this image directly to her friend Ron without saving it locally. She clicked “email a friend” button and entered Ron’s email address and clicked send button. Ron receives the mail.

#### **Non-Functional Requirements:**

1. **Look and Feel:** Visualization transitions from one form of graph to another should be smooth.
2. **Performance:** System shall not take more than 5 seconds to generate a visualization transitions.
3. **Usability:** While loading visualizations, system shall provide a status feedback to user.

#### **Non Goals:**

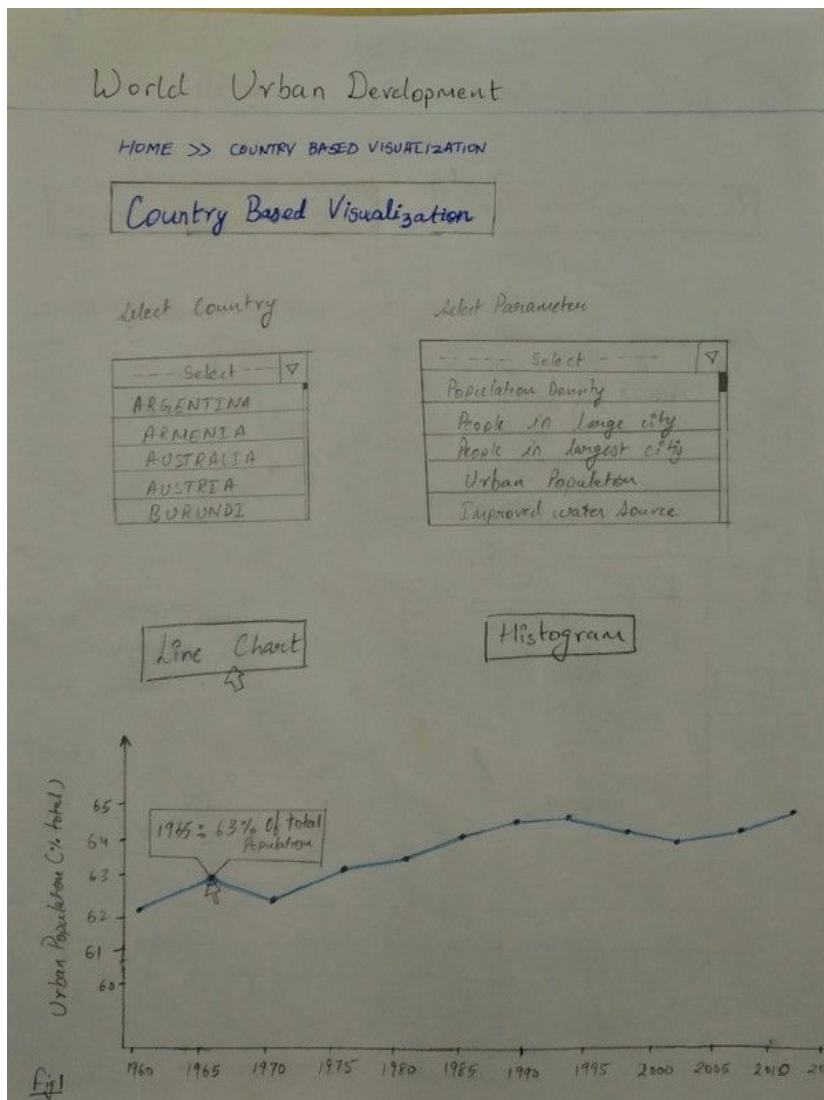
##### **Print Visualization data:**

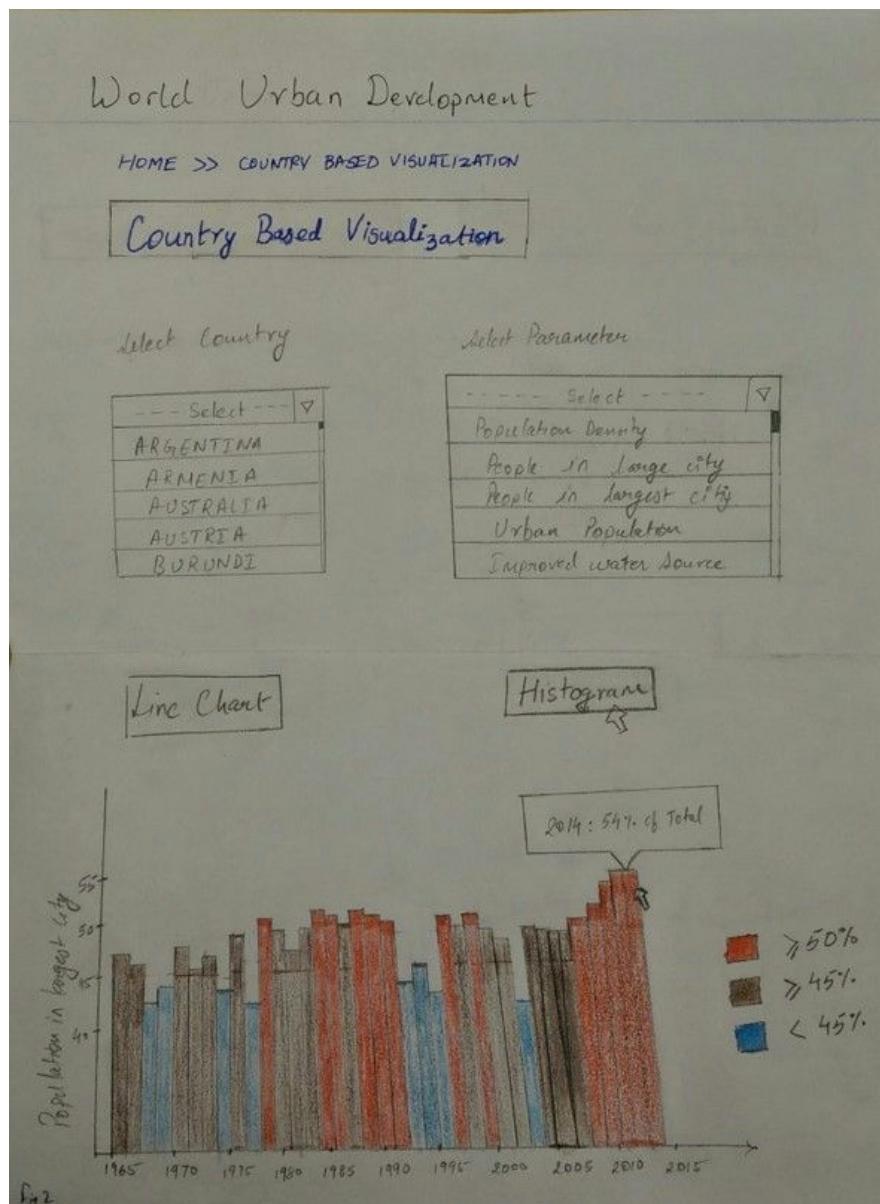
Ms. Avantika has successfully created a visual representation of data in the website. He wanted to show his wife graphs generated, as she likes analyzing them. So he clicked the print button. His computer started asking him questions regarding printing options. Upon giving these details to computer, graphs are printed directly without saving them locally.

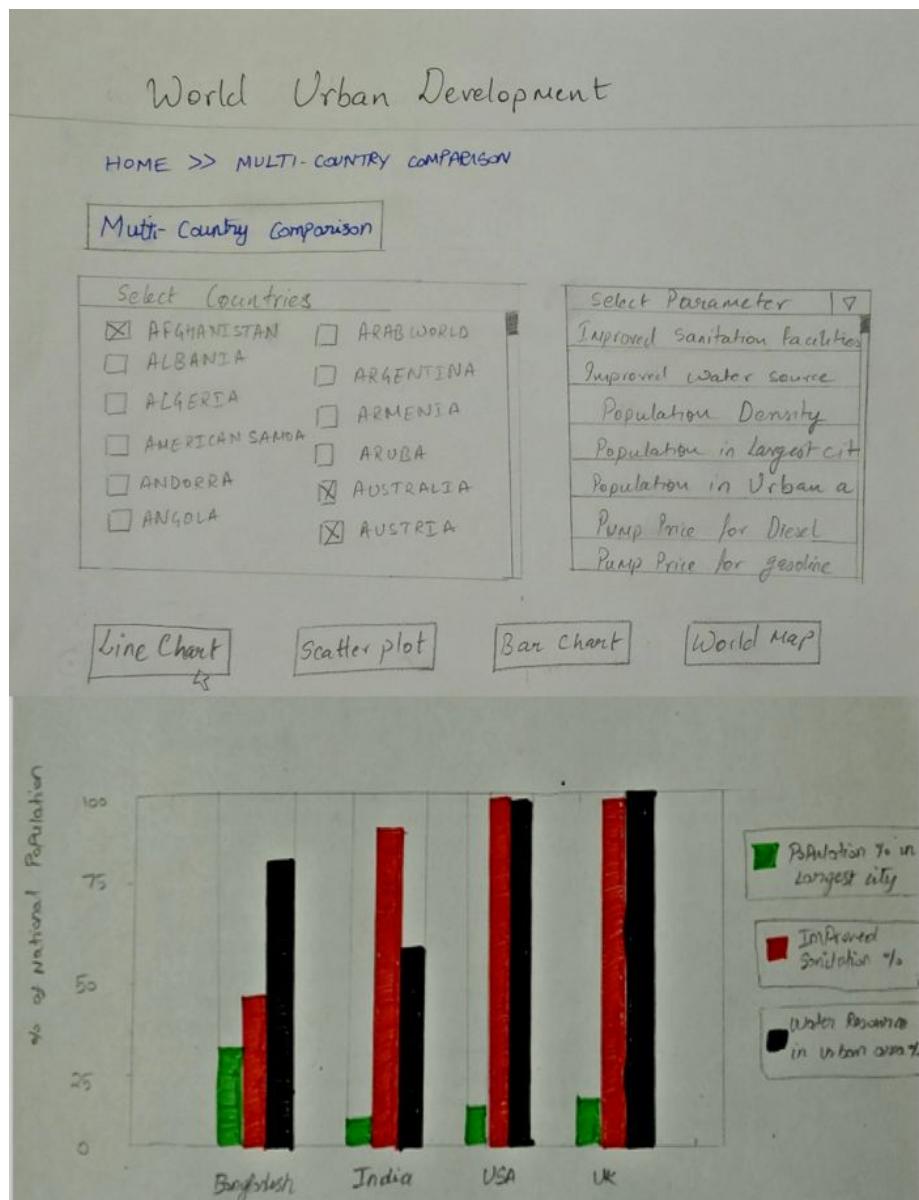


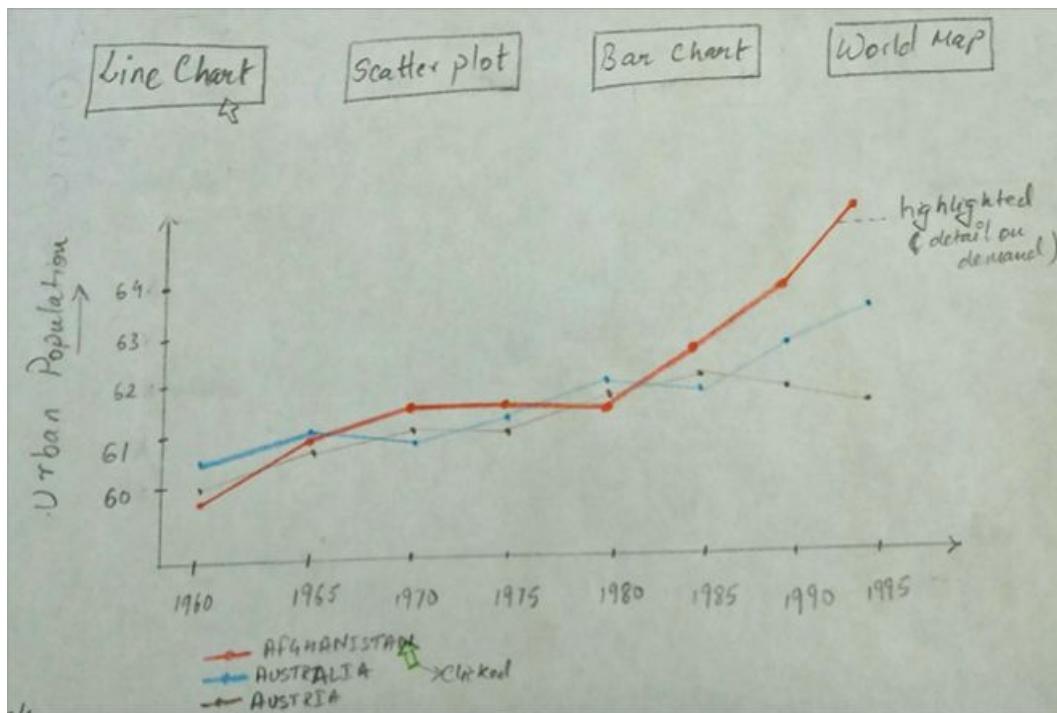
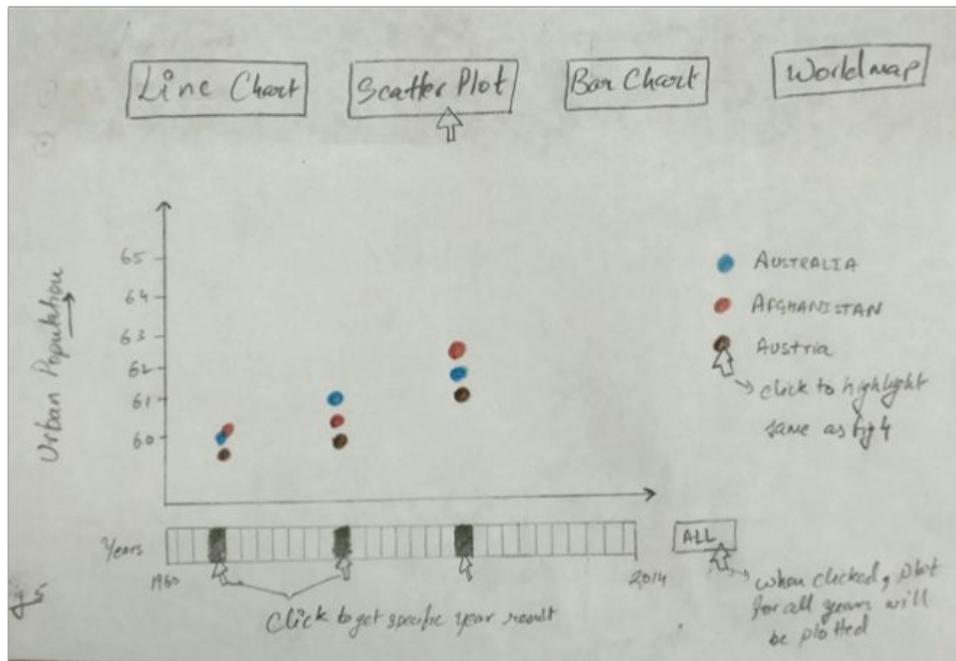
## Prototypes

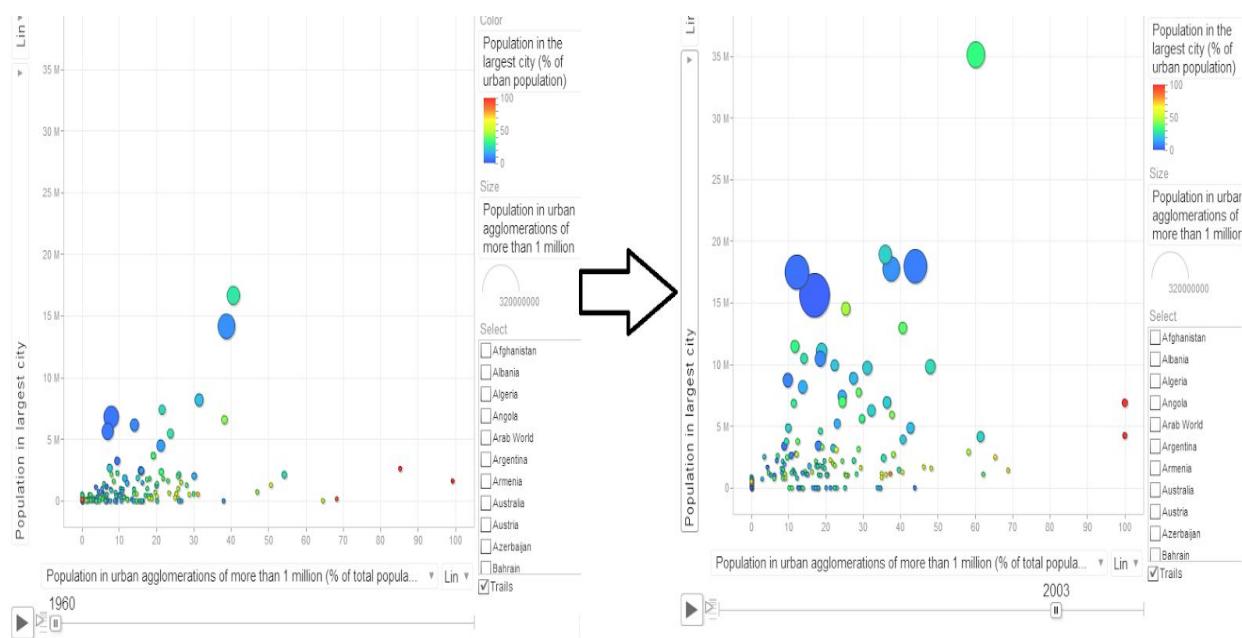
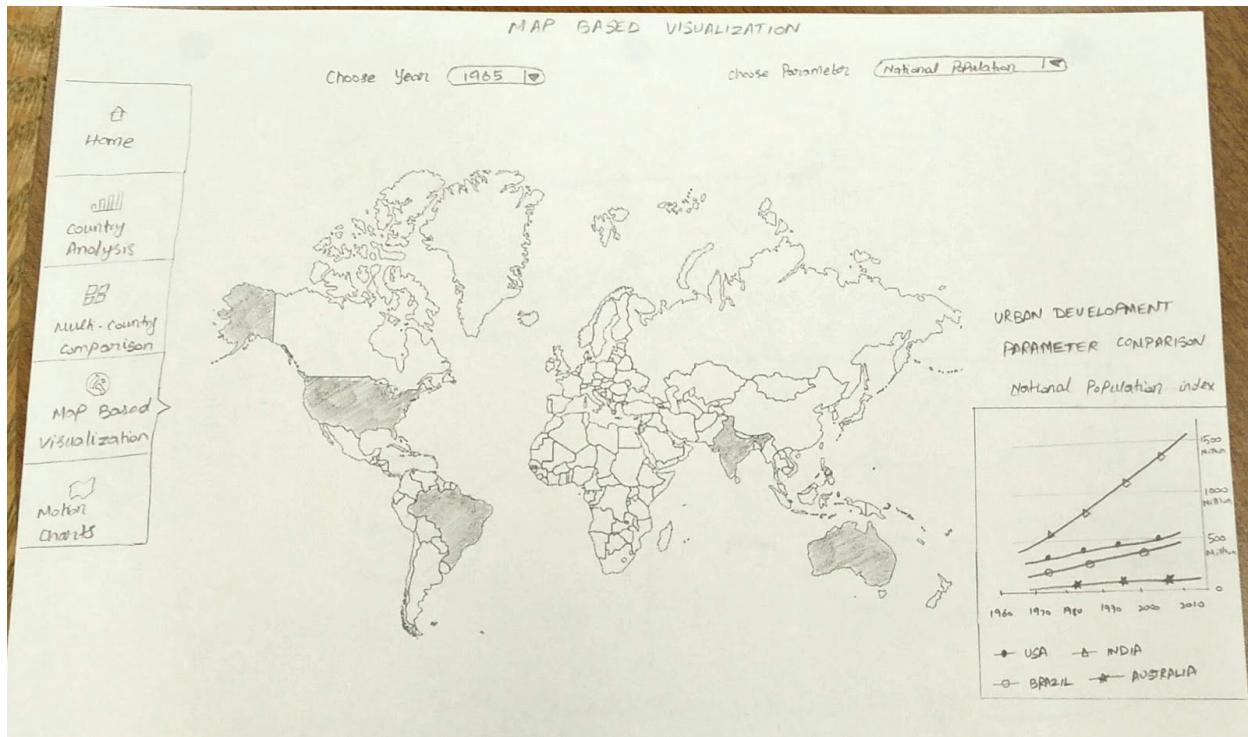
### Group Prototype 1:

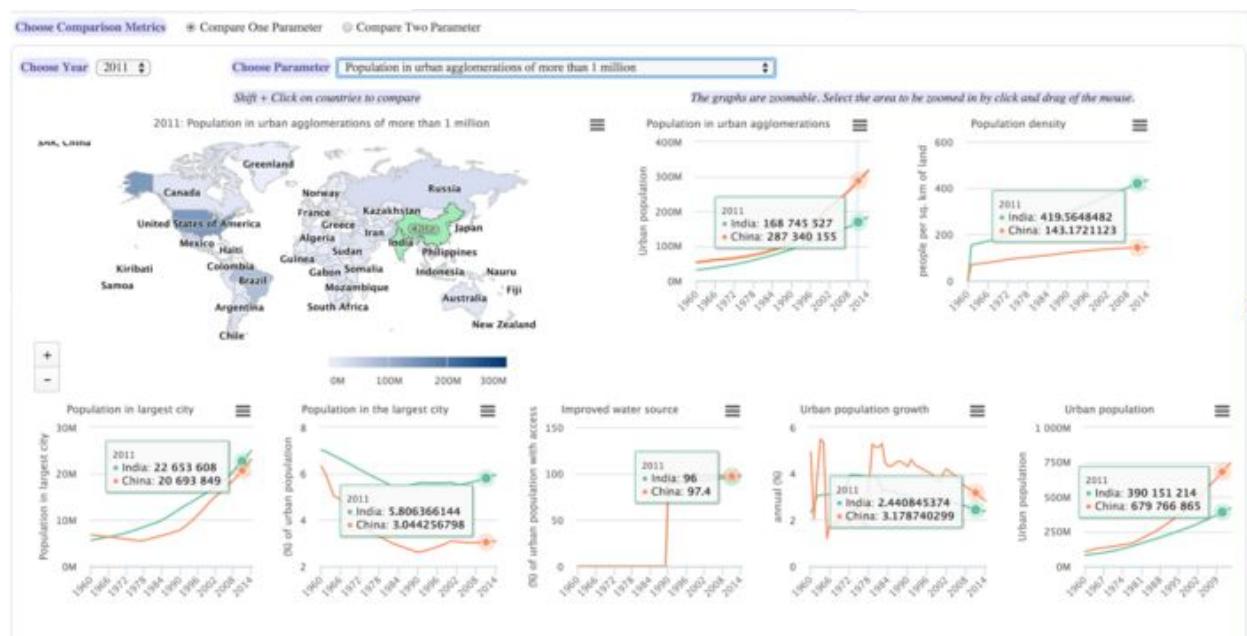




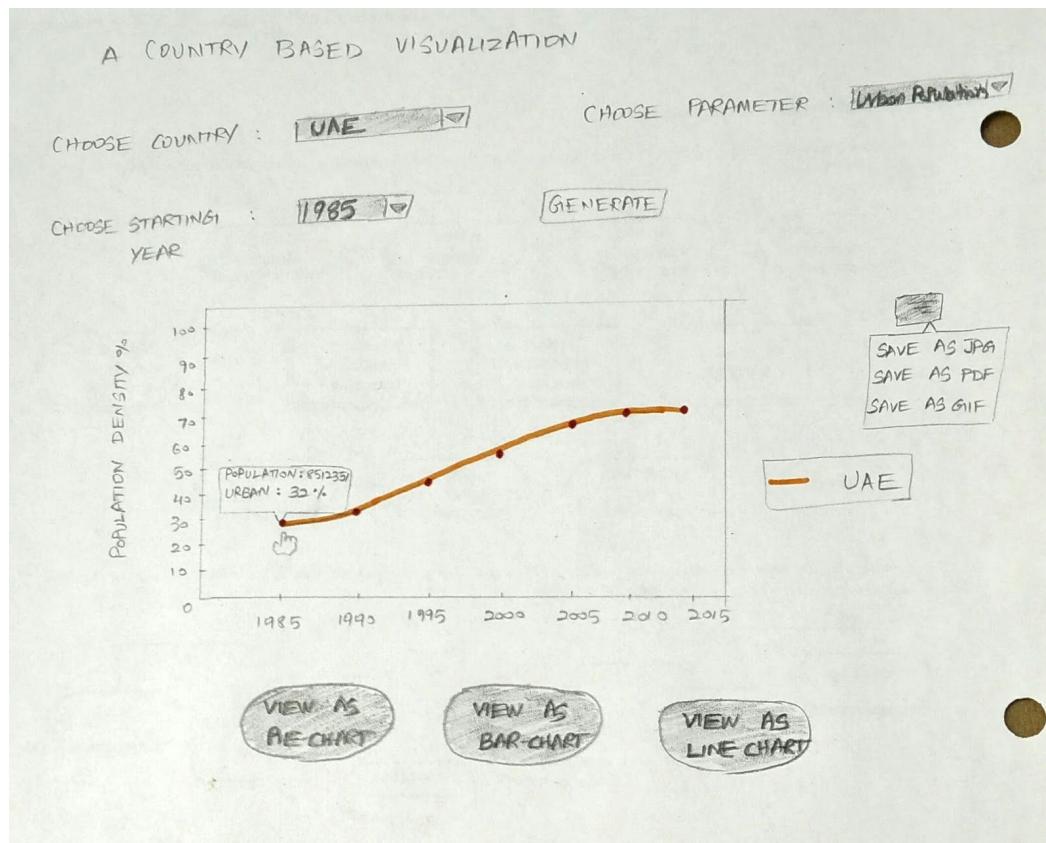


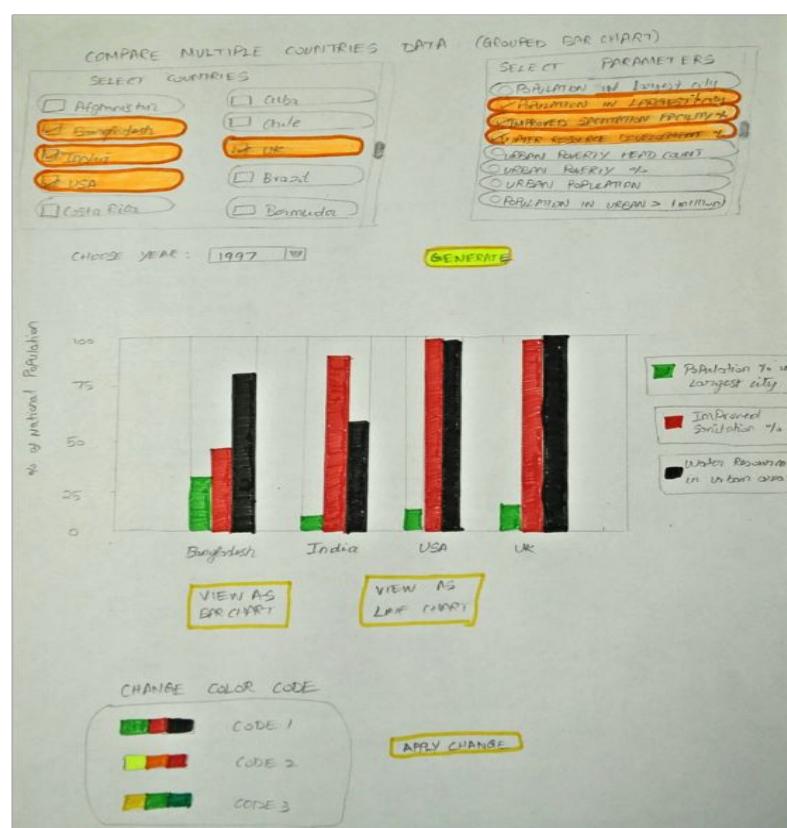
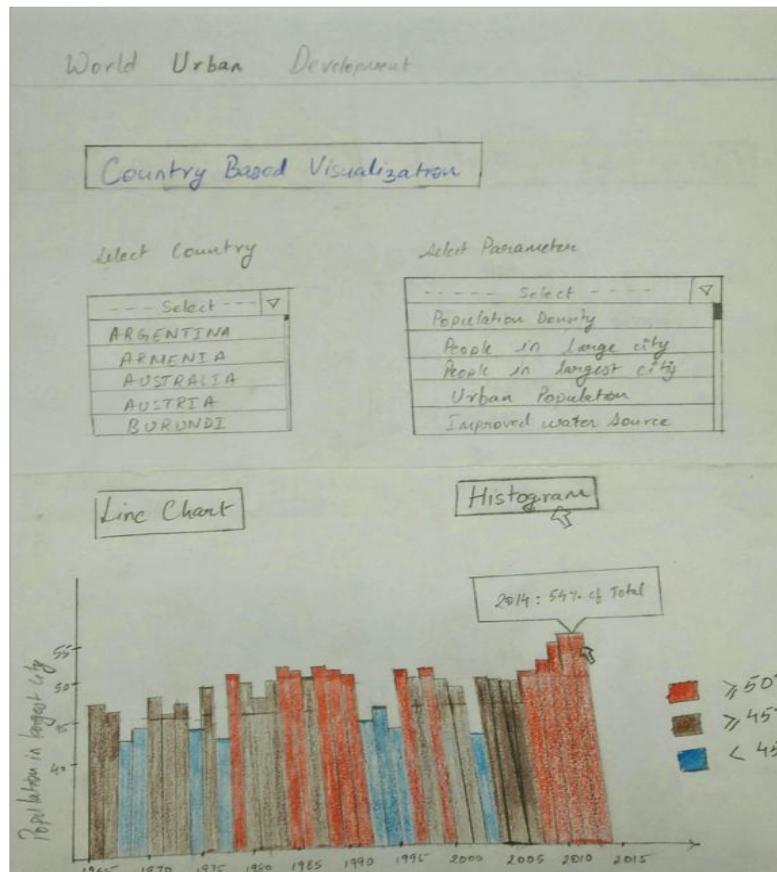


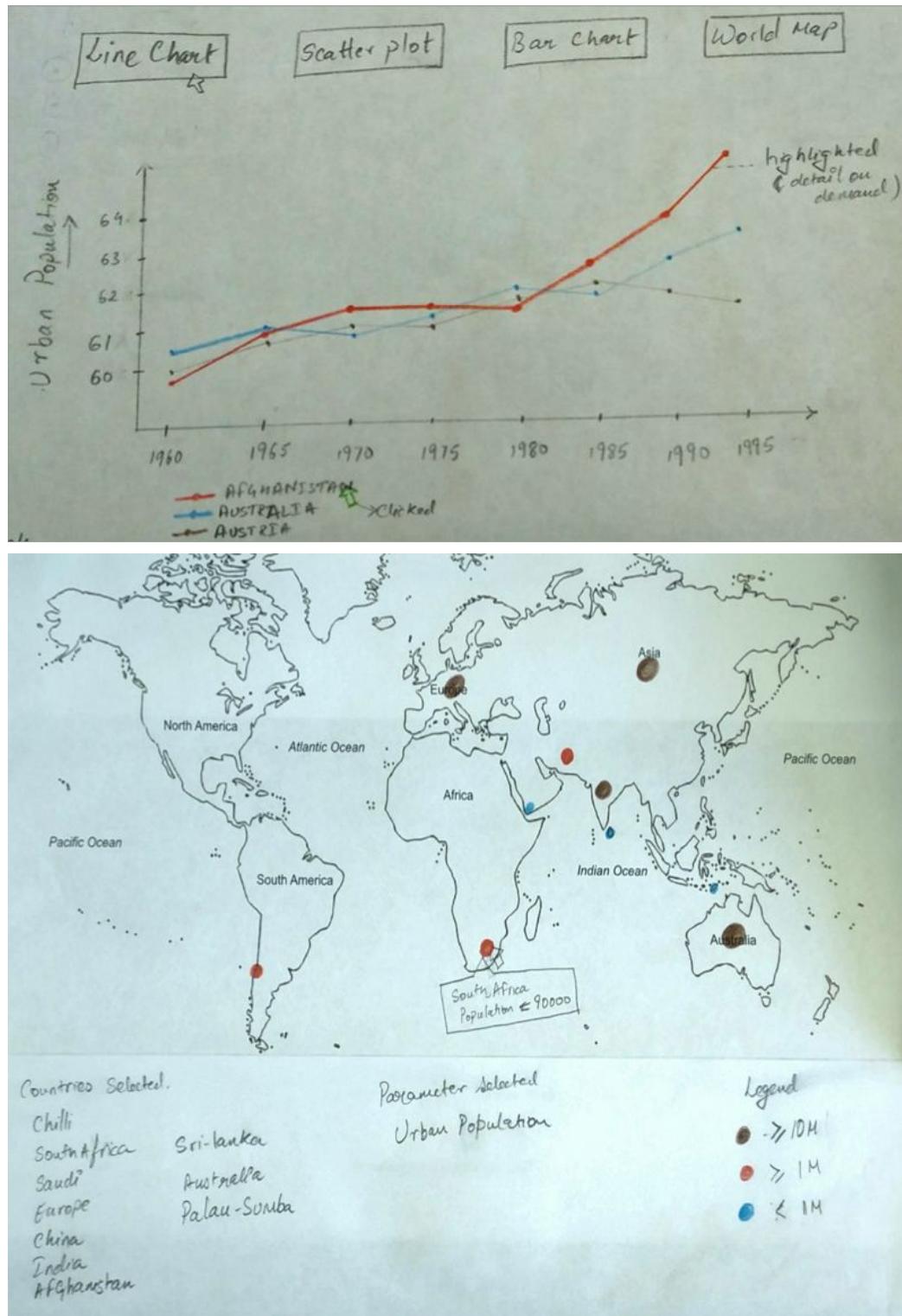


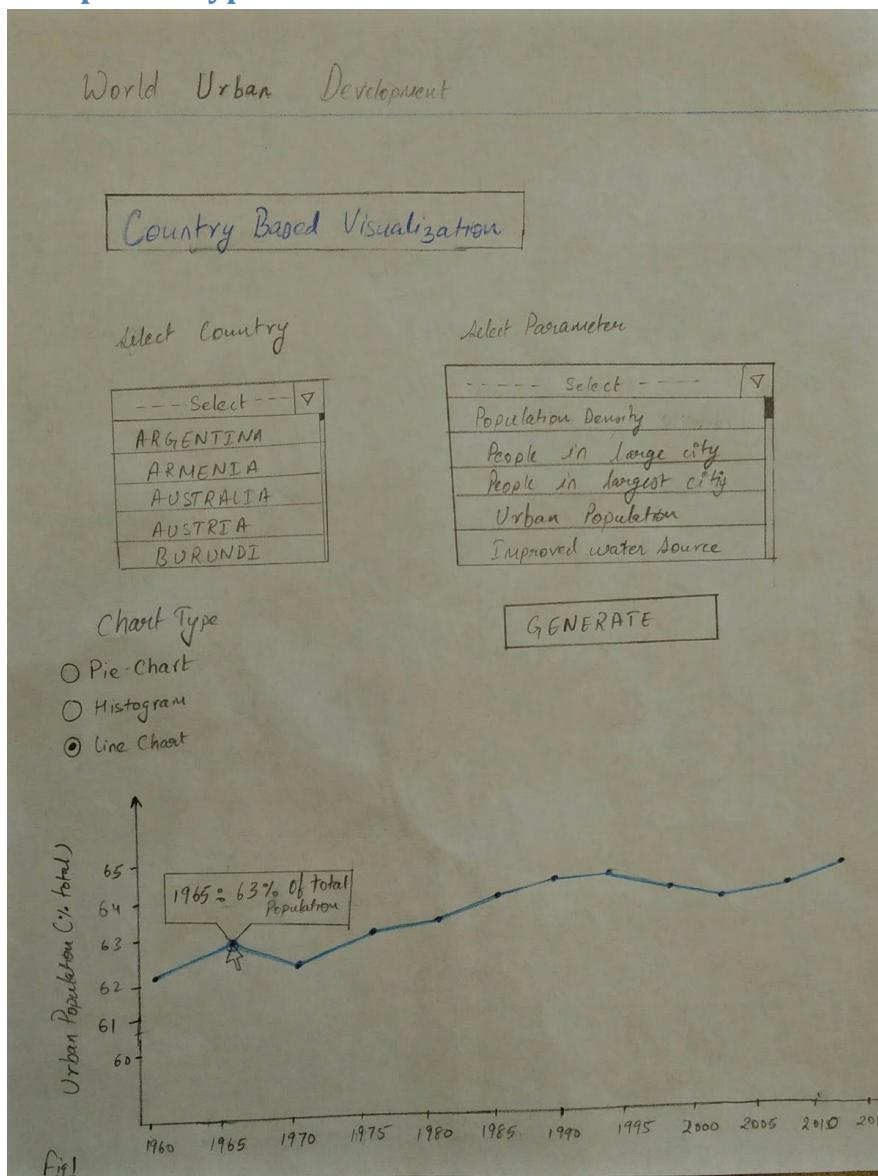


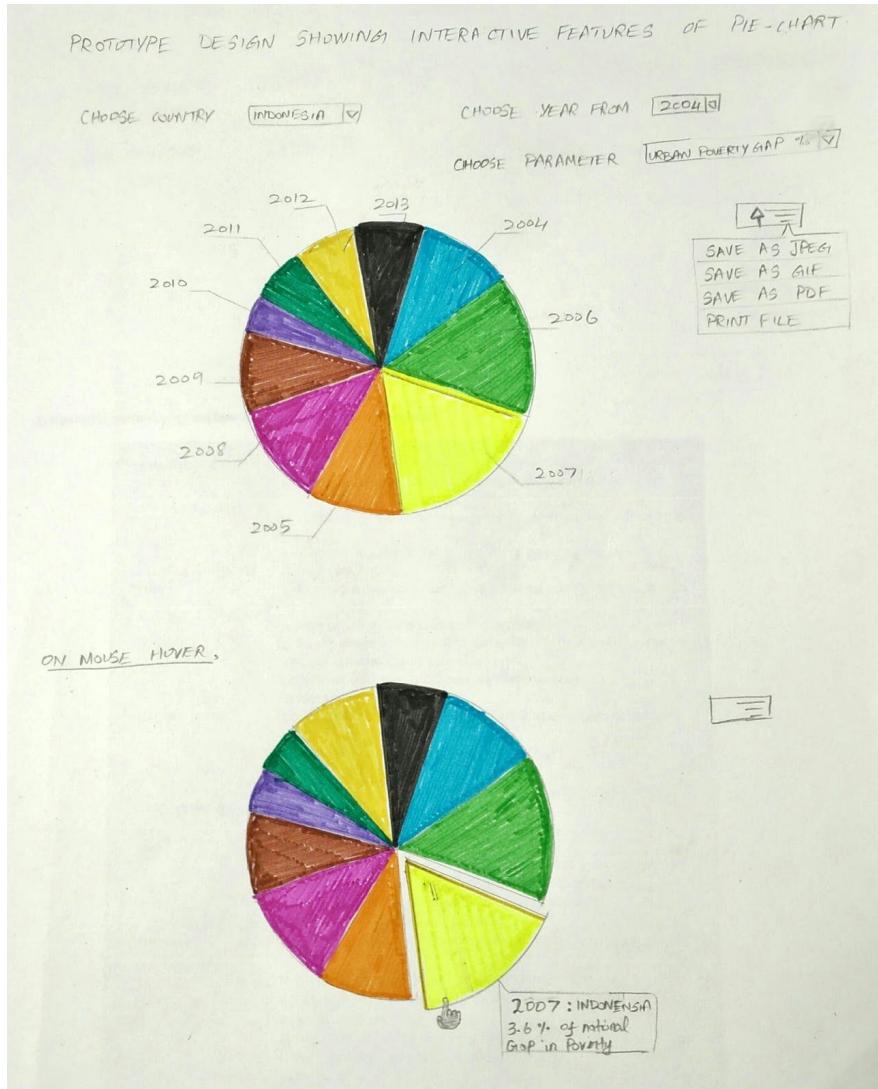
## Group Prototype 2 :

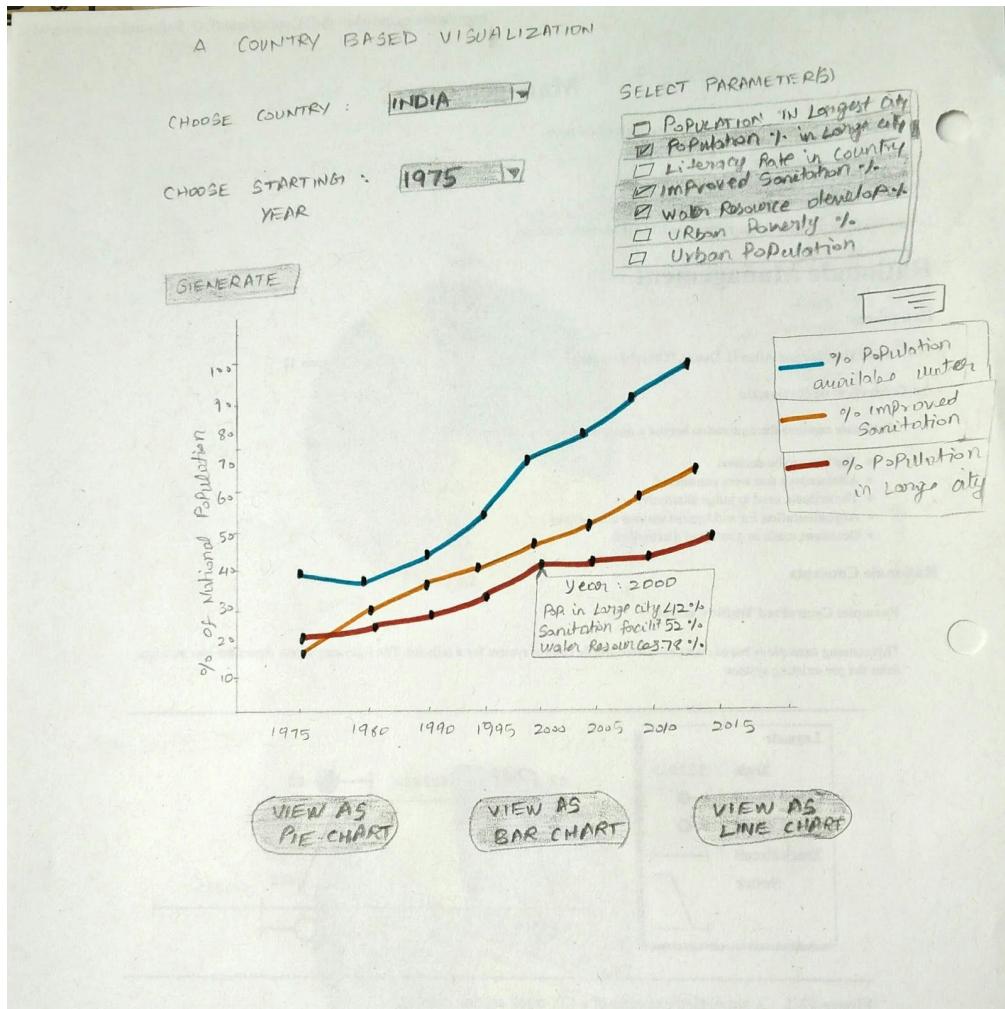


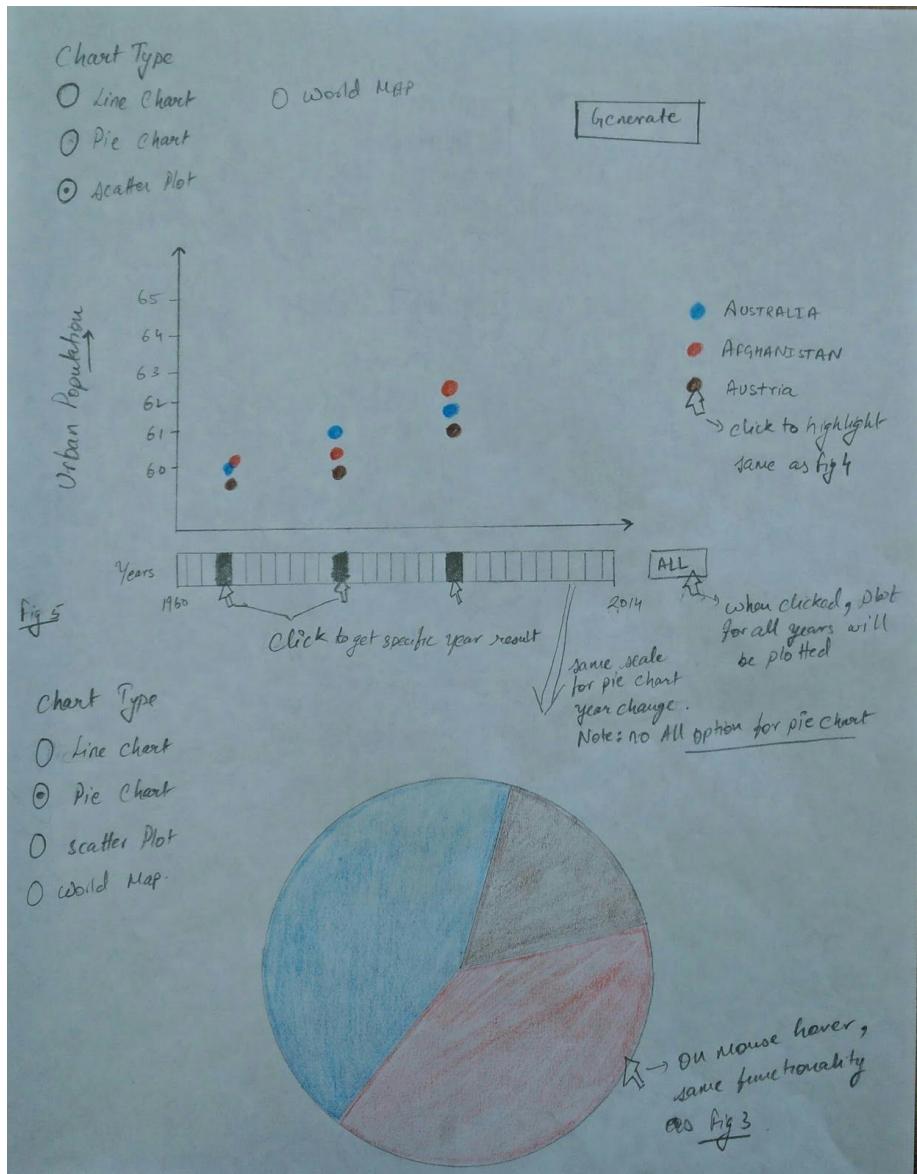


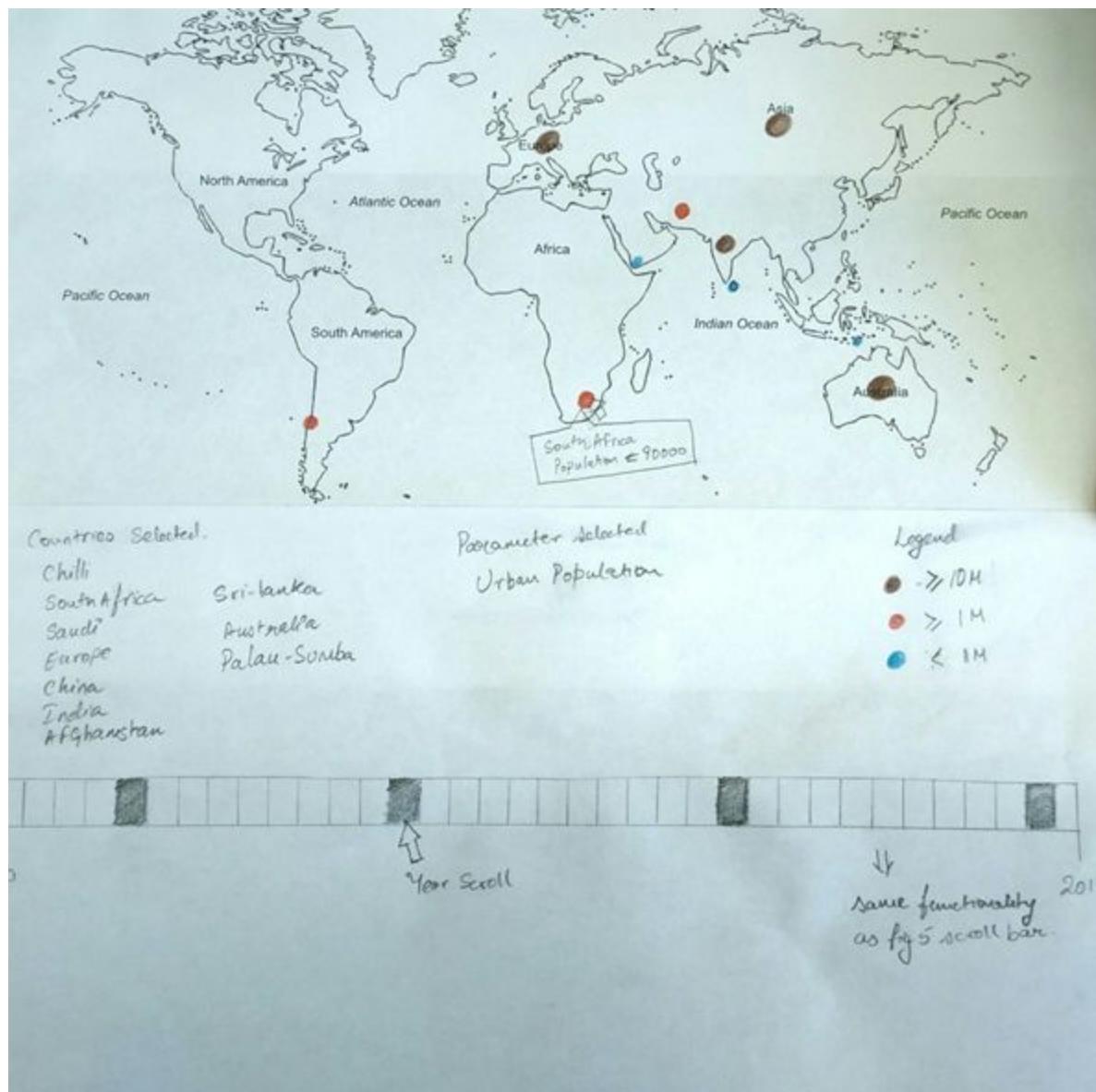


**Group Prototype 3:**









## Client's Feedback

- Minimize the page traversals for different operations - To remove individual pages for various visualizations.
- Discard Pie-chart representation of data : Visualizing urban development parameters for over 50 years in a pie-chart leads to visual clutter.
- Include Scatter Plot and Stacked bar chart for effective use of screen space and provide clear understanding.

## Collaborative Tools Used

- Version Control: Github
- Bug Tracking: Github
- Software: HTML, CSS, Highcharts.js, Angular.js, javascript, jQuery, google API
- Github link: [https://github.com/CS522Fall2015/CS522\\_Fall2015](https://github.com/CS522Fall2015/CS522_Fall2015)

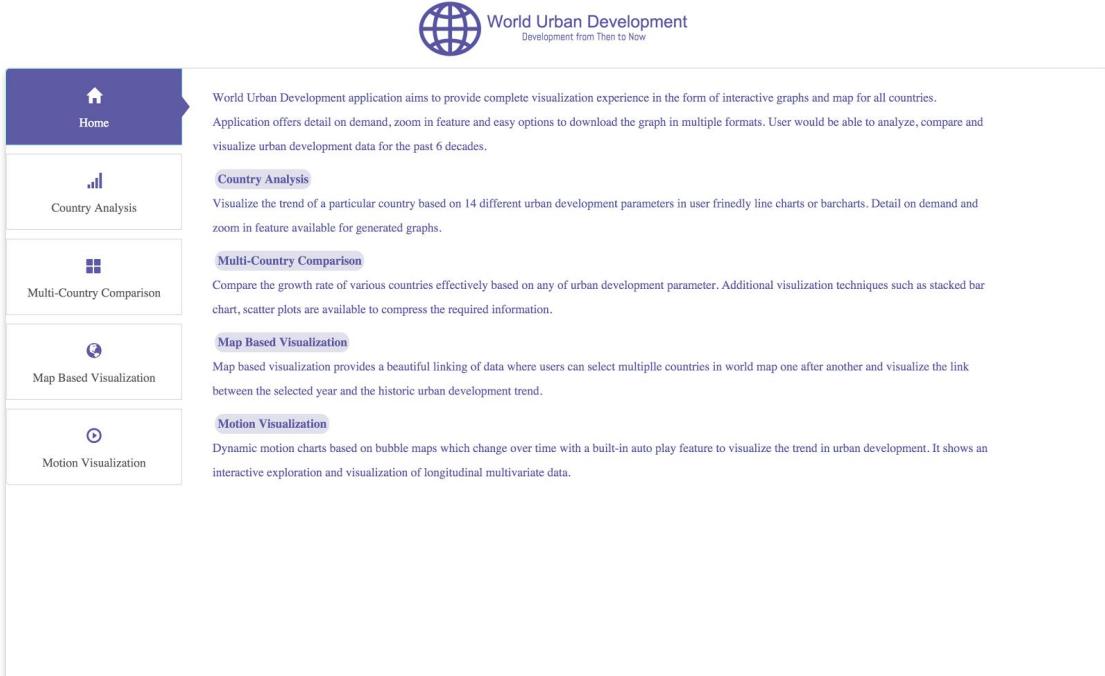
# Alpha Release Report

## Layers Completed:

Following sections were implemented fully for the alpha release on 11/23/2015.

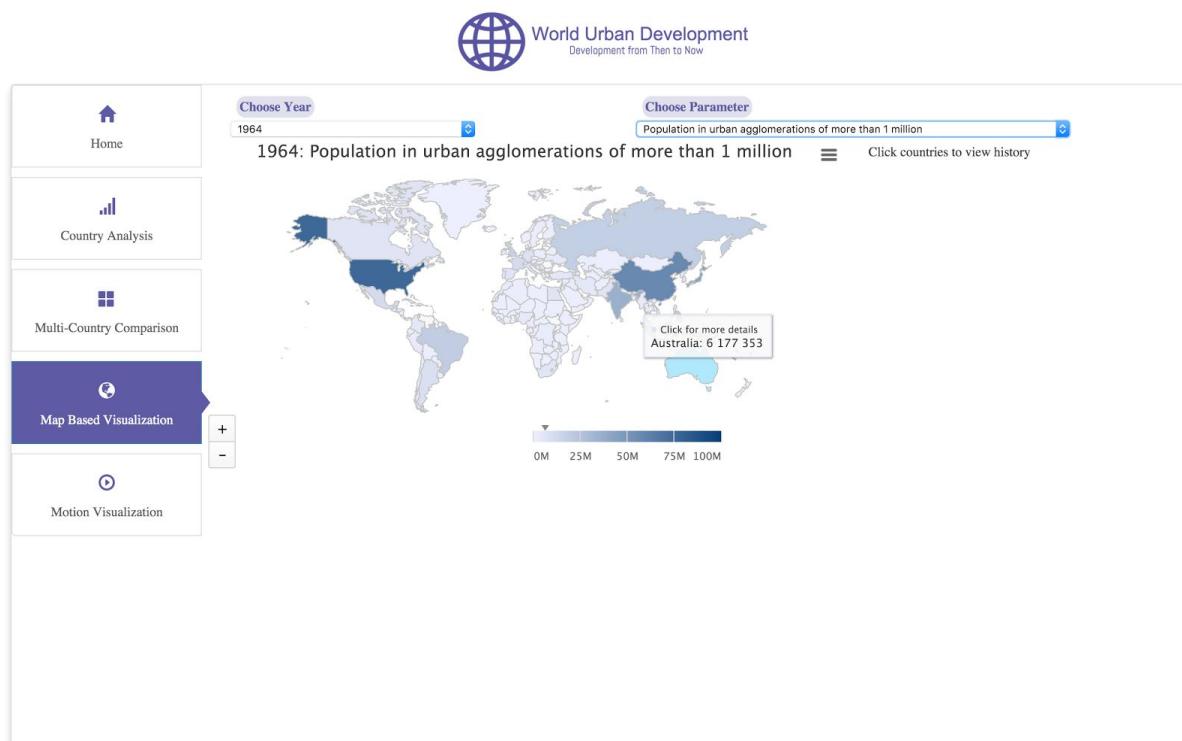
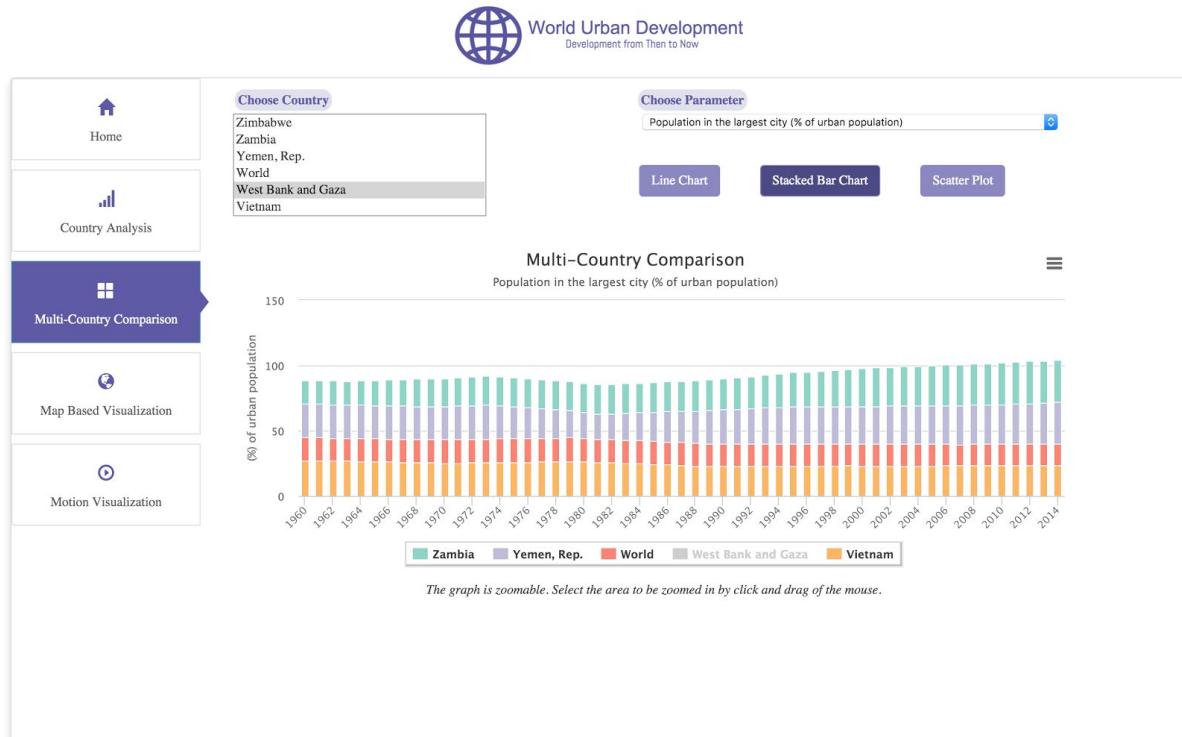
1. Complete Home page and UI for dashboard setup.
2. Single Country Analysis with various urban development parameters and functionality to change representation.
3. Multi-Country comparison with 3 different views: Line Chart, Stacked Bar Graph and Scatter Plot.
4. Functionality to download any graphical representation as PDF, JPEG, PNG or SVG Vector image.
5. Map based visualization : detail-on-demand and linking and brushing feature incorporated to show relevant details of countries selected in juxtaposed graph view along with world map.
6. Motion based visualization: playback feature of scatter plot graph representation with dynamic selection of X and Y axis parameters over period of 60 years. Feature to change color on-demand. Ability to change speed of auto-play transition, scale of graph(linear or logarithmic)

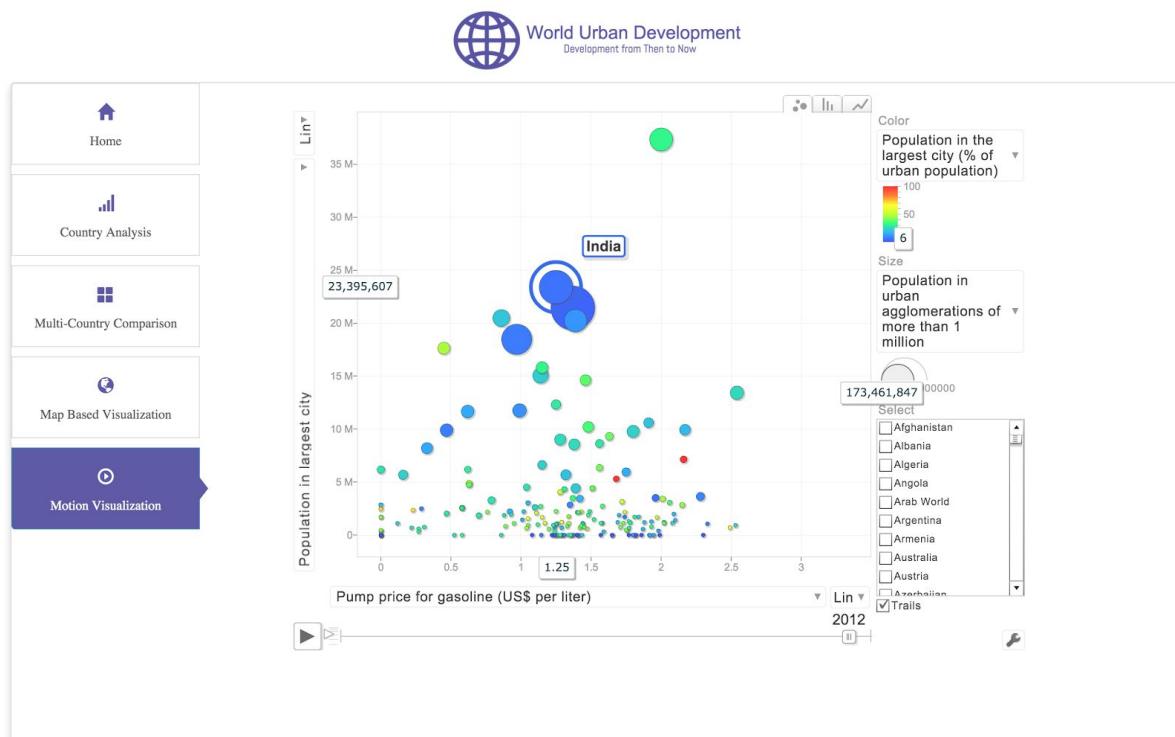
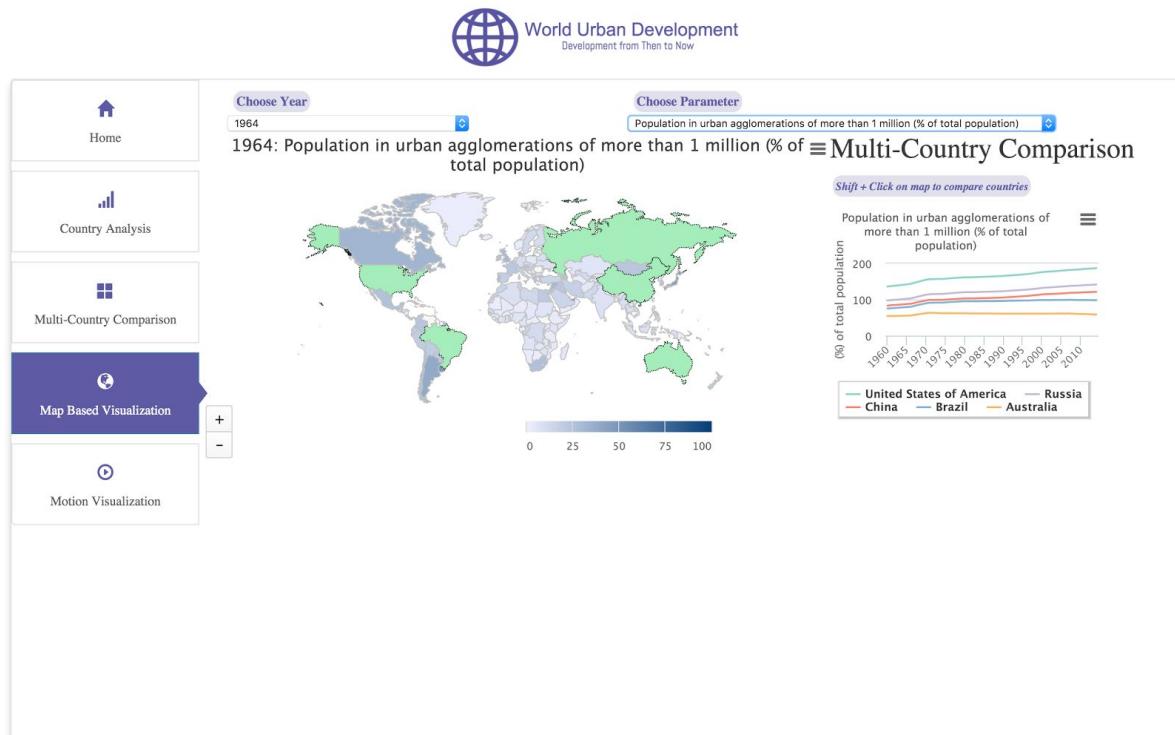
## Screenshots:

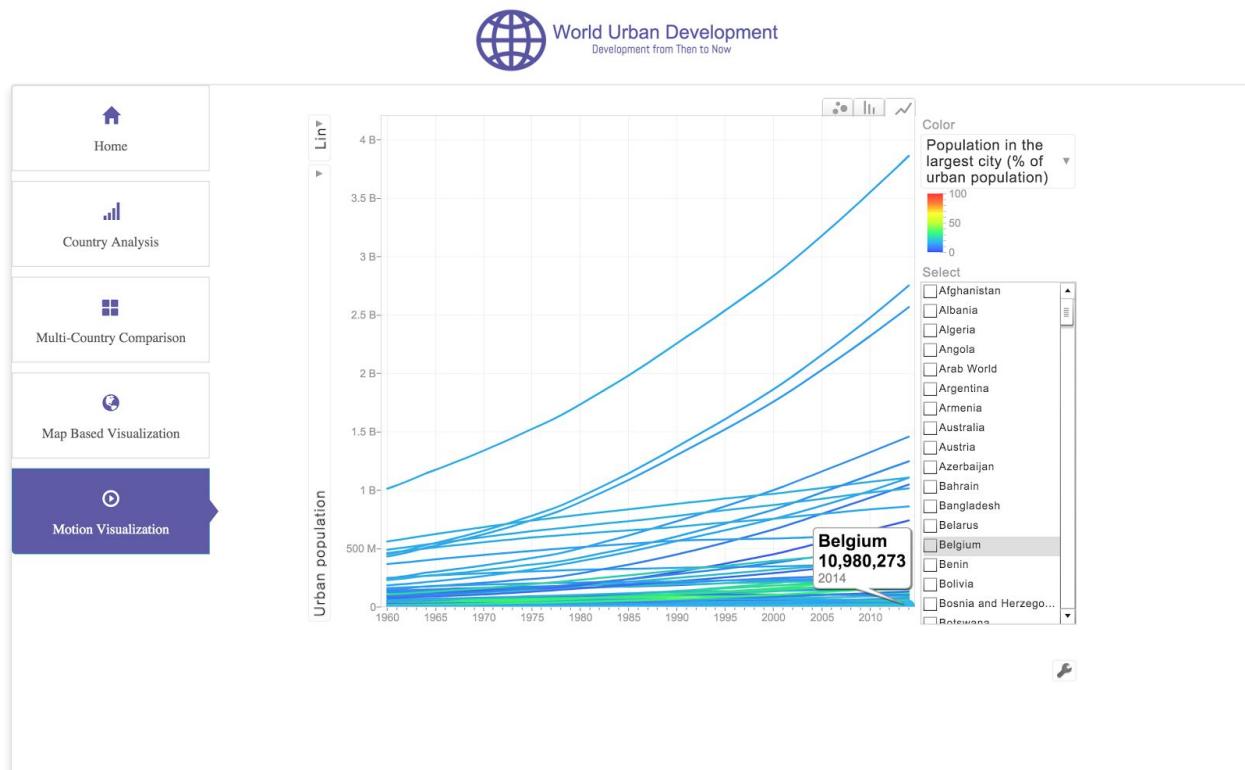
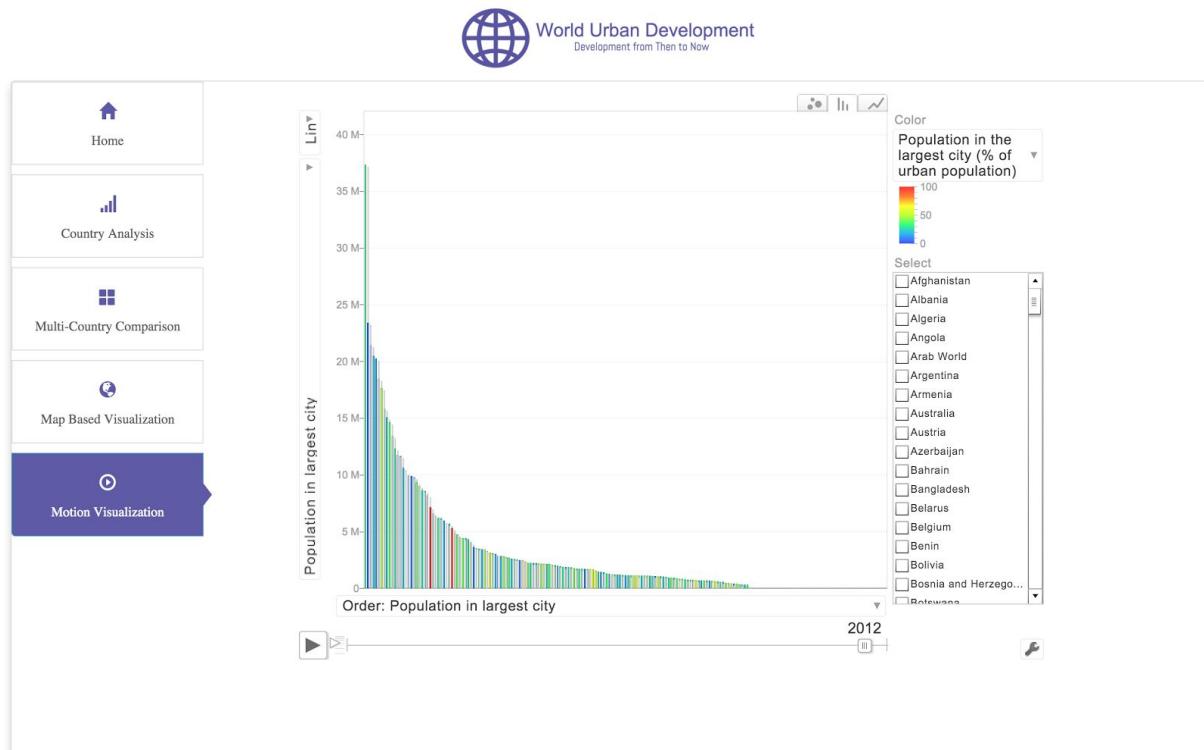


The screenshot shows the homepage of the "World Urban Development" application. At the top right is the logo "World Urban Development" with the tagline "Development from Then to Now". The left sidebar has a dark blue header with a white house icon and the word "Home". Below it are five menu items with icons: "Country Analysis" (bar chart), "Multi-Country Comparison" (grid), "Map Based Visualization" (map pin), and "Motion Visualization" (circle with dots). The main content area has a light gray background. It starts with a paragraph about the application's purpose: "World Urban Development application aims to provide complete visualization experience in the form of interactive graphs and map for all countries. Application offers detail on demand, zoom in feature and easy options to download the graph in multiple formats. User would be able to analyze, compare and visualize urban development data for the past 6 decades." Below this are four sections with headings and descriptions: "Country Analysis" (Visualize the trend of a particular country based on 14 different urban development parameters in user friendly line charts or barcharts. Detail on demand and zoom in feature available for generated graphs.), "Multi-Country Comparison" (Compare the growth rate of various countries effectively based on any of urban development parameter. Additional visualization techniques such as stacked bar chart, scatter plots are available to compress the required information.), "Map Based Visualization" (Map based visualization provides a beautiful linking of data where users can select multiple countries in world map one after another and visualize the link between the selected year and the historic urban development trend.), and "Motion Visualization" (Dynamic motion charts based on bubble maps which change over time with a built-in auto play feature to visualize the trend in urban development. It shows an interactive exploration and visualization of longitudinal multivariate data.).









### **Gaps between specification and implementation of Alpha release:**

All the specifications mentioned in requirements document for Alpha release has been met completely. Based on the feedback of client and Wizard of Oz demo, new features like motion based graphical views, brushing and linking functionality with a world map view and line graph have been implemented for alpha release of the project. However we need to enhance few features so that how to use them become more evident.

### Alpha Testing Tasks:

1. Compare the trend in urban development growth for multiple countries, namely: United States, United Kingdom, United Arab Emirates, Ukraine, Uganda, Turkmenistan, Turkey and Tunisia, for parameter “Urban population growth (annual%)” and rank top 5 countries in decreasing order of annual %.
2. For the year 2010 and parameter “Population in Urban agglomeration more than 1 million”, select the countries “USA, Australia, Brazil, India, Russia, Japan and Canada” from a map and compare the trend of urban development growth rates and rank the countries in decreasing order of development for the parameter selected in the year 2012.
3. Compare and analyze the trend among countries taking 2 parameters namely “population in largest city” and “Urban Population(% of total)” into consideration simultaneously, select the countries Japan, USA, Argentina, France, China, Romania, Indonesia and India, and find what was the Population in the largest city and the corresponding Urban population % in the year 2009 for the country ‘Indonesia’.
4. Bonus Round Questions:

Now let's take it to Africa continent. Try to find countries: Angola, Sudan, Mali, Ghana, Zambia and Somalia on the map and find which country is 4th best when it comes to Urban development on the basis of Population in the largest city for the year 2005.

Analyse the trend of urban development growth for “Mongolia” with parameter “Population in Largest City (% of Urban Population)” and tell in approximation what is the maximum attained % in the urban development for the time span between 1960-1990.

### **Alpha Testing Questionnaire:**

1. What were the 3 features that you liked and disliked about the website?
2. How easy was navigation among various pages on a scale of 10 with 10 being very easy? And how helpful was the description on home while performing tasks on a scale of 10 with 10 being very informative.
3. On the scale of 10 with 10 being very easy, how easy was it to accomplish given tasks?
4. On a scale of 10 with 10 being less cognitive load, how would you grade the website on cognitive load on user?
5. On a scale of 10 with 10 being effective, how effective were the color schemes while data representations?
6. How was overall UI experience of the website?
7. What would be your most frequently used task from the website?
  - a. Single country comparison
  - b. Multi country comparison
  - c. Map based visualization
  - d. Motion Based visualization of graphs
8. Do you Agree or Disagree with the application content being concise but informative?
9. Was the tagline informative enough?
10. How attractive was the homepage design with vertical tabs option?
11. How effective did you find the tooltip description provided in all the graphs?
12. How user friendly was the zoom feature to use in the graphical representation?

#### **Participant #1:**

1. Liked: Vertical tab arrangement, detail comparison on click of graph, motion chart  
Disliked/Improvement: Need more information on pages, need tutorials, less information on how to use motion chart.
2. 8/7
3. 6. Questions were long and require more time
4. 9
5. 9
6. It was a good experience to use this website. With few additional information, using this website will become very smooth
7. Map based Comparison

#### **Additional Comments:**

Could not understand how to use motion chart, need tutorial on how to use it.

#### **Participant #2:**

1. Liked: Categorization of functionality, UI representation, homepage description.  
Disliked/Improvement: Need to make motion chart more informative.
2. 10/10

3. 7
4. 8
5. 10
6. Liked the vertical tabs, and very informative description on home page to use website.  
Motion chart need a little more description as never used before so didn't had information.
7. Map and motion based.

**Additional Comments:**

Interface very straightforward to use, however motion chart require a little more description.

**Alpha Testing Analysis:**

Parameters	Tasks	Participant 1	Participant 2	Participant 3	Success %
Task Success	Task 1	100%	100%	80%	93.33%
	Task 2	100%	100%	100%	100%
	Task 3	60%	90%	100%	83.33%
					<b>Avg. time to complete each task</b>
Time Taken (in sec)	Task 1	123	65	160	116
	Task 2	95	67	90	83
	Task 3	143	100	130	121
	<b>Avg Time to complete tasks</b>	120	74	126	109
					<b>Task errors</b>
Errors	Task 1	0	0	1	1
	Task 2	1	0	0	1
	Task 3	2	1	0	3
	<b>Total errors</b>	3	1	1	5

## Participant's Feedback:

1. Users were happy with color scheme and overall UI experience and found interface pretty clear to use.
2. Users liked the navigation in vertical tabs easy to use.
3. Users liked the Home page description as it helped them to actually accomplish their tasks.
4. Few Selections on webpage require a brief description.
5. Cognitive load on user's memory was marginal.
6. User felt a need for tutorial to use the website.
  - i. *Resolution: To have help menu which will contain more descriptive summary of each functionality to make it more intuitive for people without background knowledge to effectively use the application.*
  - ii. *Resolution: To add a video tutorial for basic functionalities of our website to guide new users.*
7. User were unable to use zoom-in feature in 1 tab as it was not evident.
  - i. *Resolution: Mention a small 3-4 words on zoom-in feature as added on other pages.*
8. Motion Visualization require a little more description on page to make things evident. As this implementation is new, user felt that a tutorial would be best.
  - i. *Resolution: We plan to have a tutorial added in the help section and also a video tutorial.*
9. Tasks assigned were difficult.

## Observations:

1. The users did not read home page before starting with the tasks assigned to them.
2. Once the user were stuck, then reading the homepage descriptions guided them to correct location in less than 3 seconds after reading description.
3. First task took a lot of time for the tester and once he was familiar with the controls, second and third task was done much faster.
4. User tried to select parameter first rather than selection country and failed to do so. This enabled him to see through country selection being mandatory.
5. Having tooltip on graphs in an order will help user find answers more faster.
6. For motion chart visualization, user was not able to locate x and y coordinate for at-most 10 seconds after logging onto that page.
7. Users were able to get accurate information from the tooltip.
8. In motion based graph, user was not able to realize variable parameter selection in Y axis easily.
9. Country name displayed in world map helped the user to easily locate them and complete the given task.
10. User did not use the play button to visualize the motion based graph. He manually slided through the years to perform the given task.



## Beta Release Report

Youtube Video Link for project :[Demo](#)

### Layers Completed:

Following sections were implemented fully for the beta release on 12/04/2015.

1. Based on user's suggestion and ease of use, scrolls in page have been completely removed.
2. Created small multiples of country based parameter graph and linked with world map.
3. Overlayed graphs are provided with synchronized tooltip for easy relation among different parameters.
4. Changed the visual layout to horizontal tabs for better user clarity and space utilization.
5. Incorporated dedicated help sections with step-by-step instructions and snapshots.
6. Included a video to demonstrate the working of the application for new users.

### Screenshots:



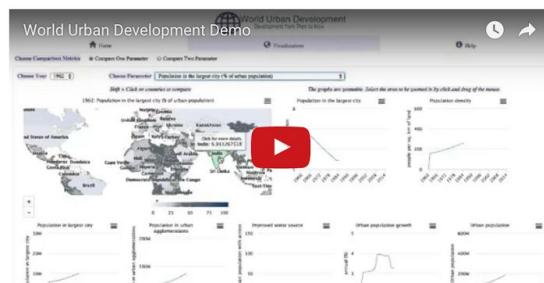
World Urban Development application aims to provide complete visualization experience in the form of interactive graphs and map for all countries. Application offers detail on demand, zoom in feature and easy options to download the graph in multiple formats. User would be able to analyze, compare and visualize urban development data for the past 6 decades. A unique feature of our website is ability to compare development of countries based on multiple parameters in a singel overlayed view for better understanding. Two dimensional visualization, Auto Play feature, ability to control the speed, on-demand color change are some of added functionalities.

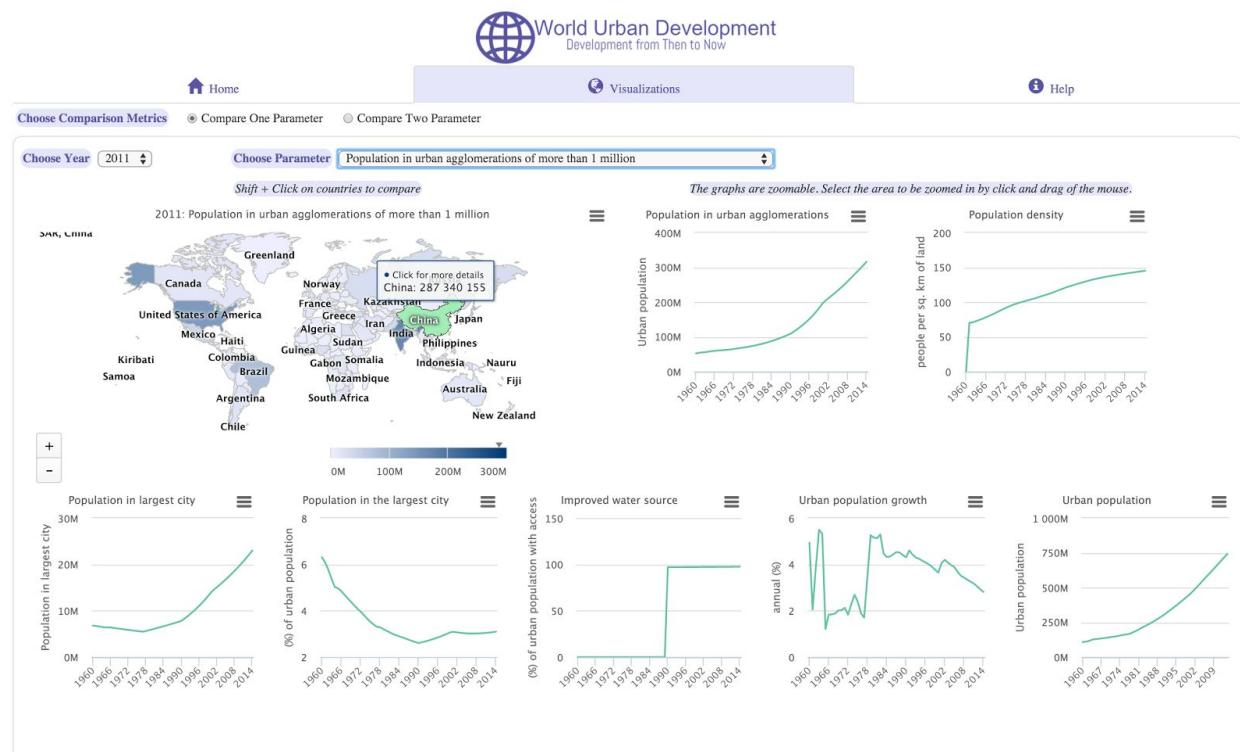
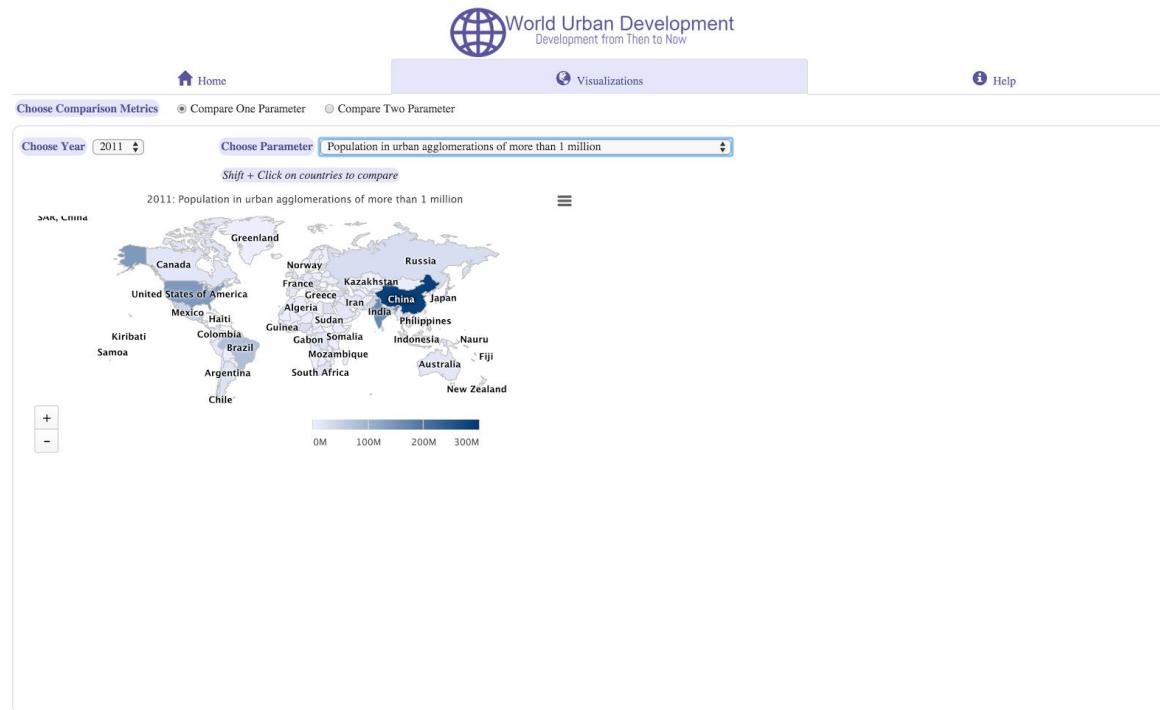
#### Map Based Visualization

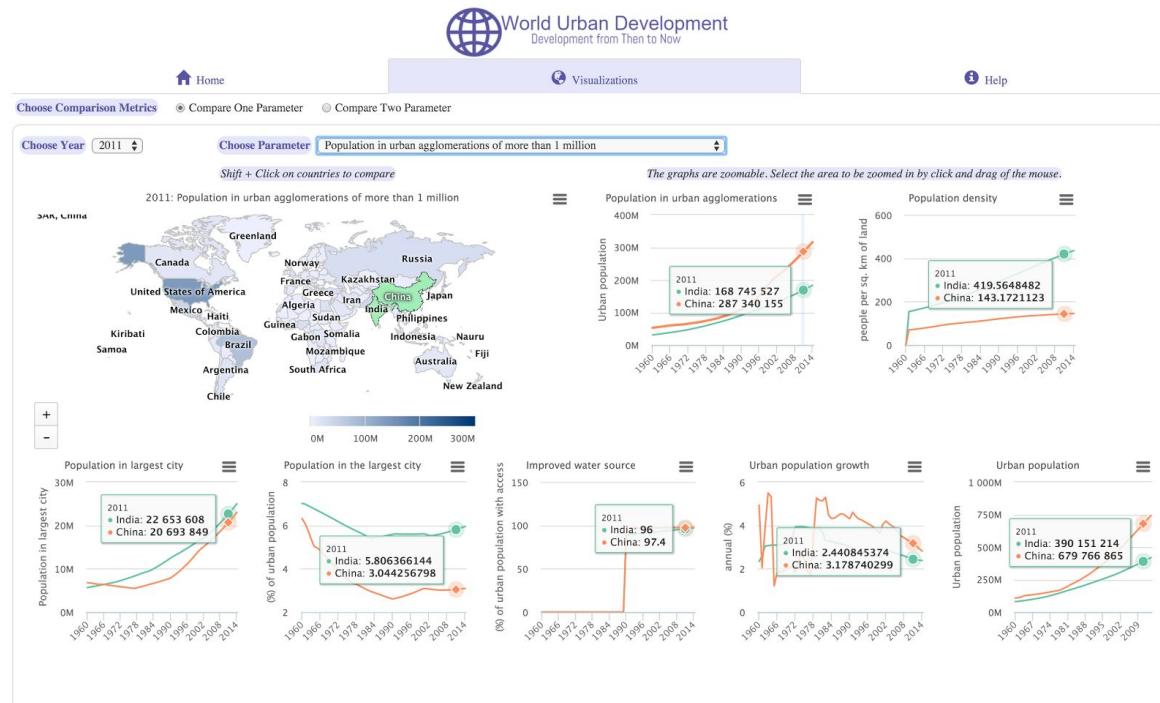
Map based visualization provides a beautiful linking of data where users can select multiple countries in world map one after another and visualize the link between the selected year and the historic urban development trend. Users can select a particular year and a parameter from 14 most used urban development indices. A world map view is provided for required year. User can choose sequence of countries to compare them for historic period from 1960 to 2014 plotted against different parameters.

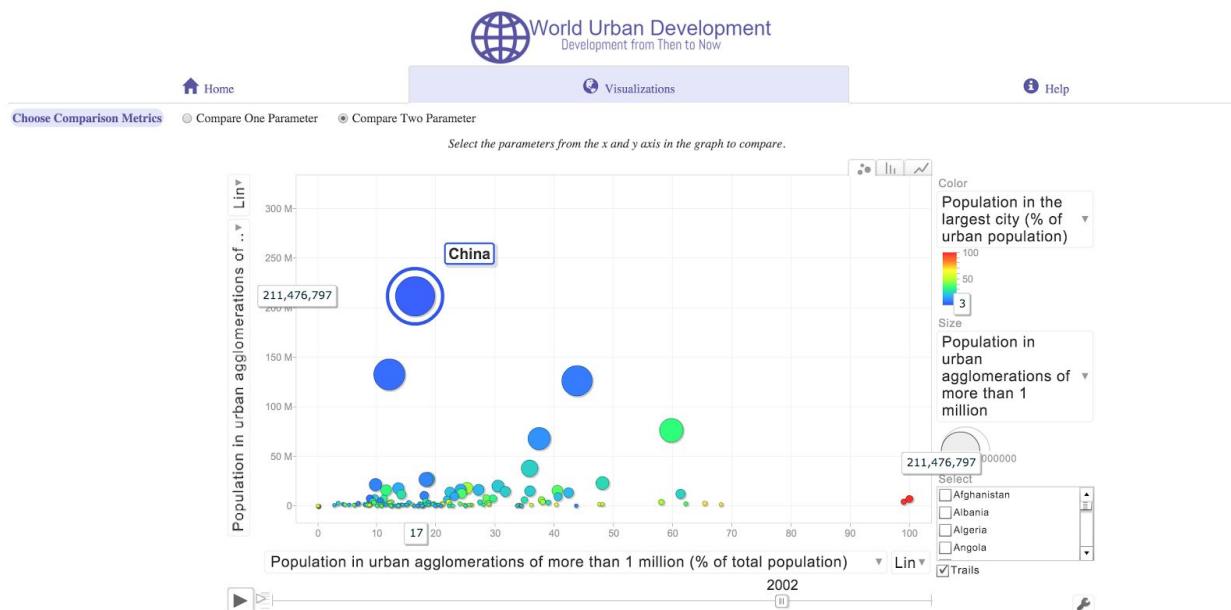
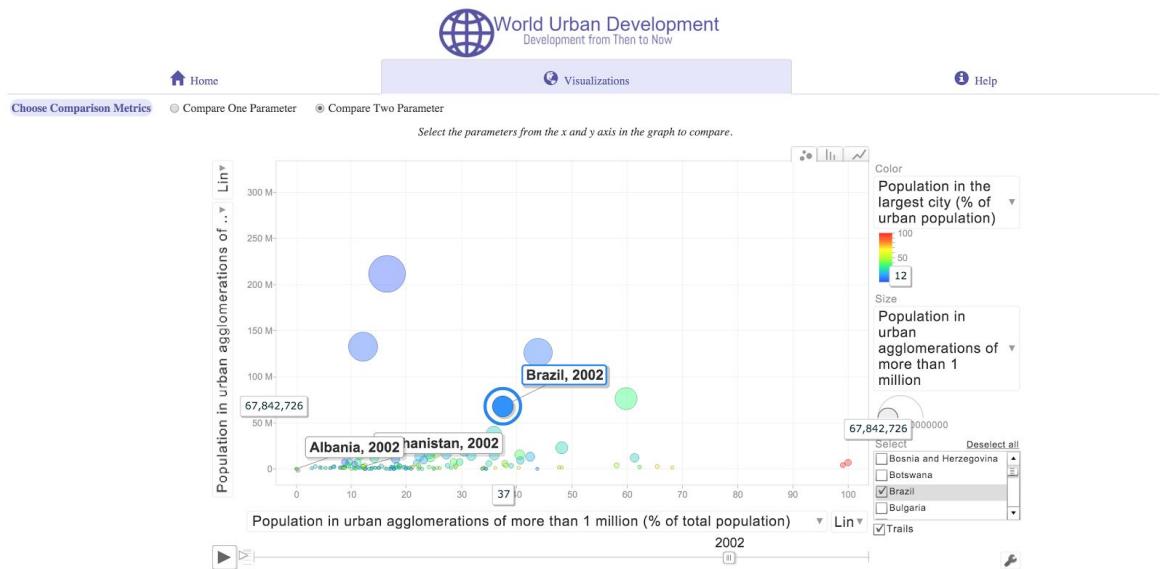
#### Motion Visualization

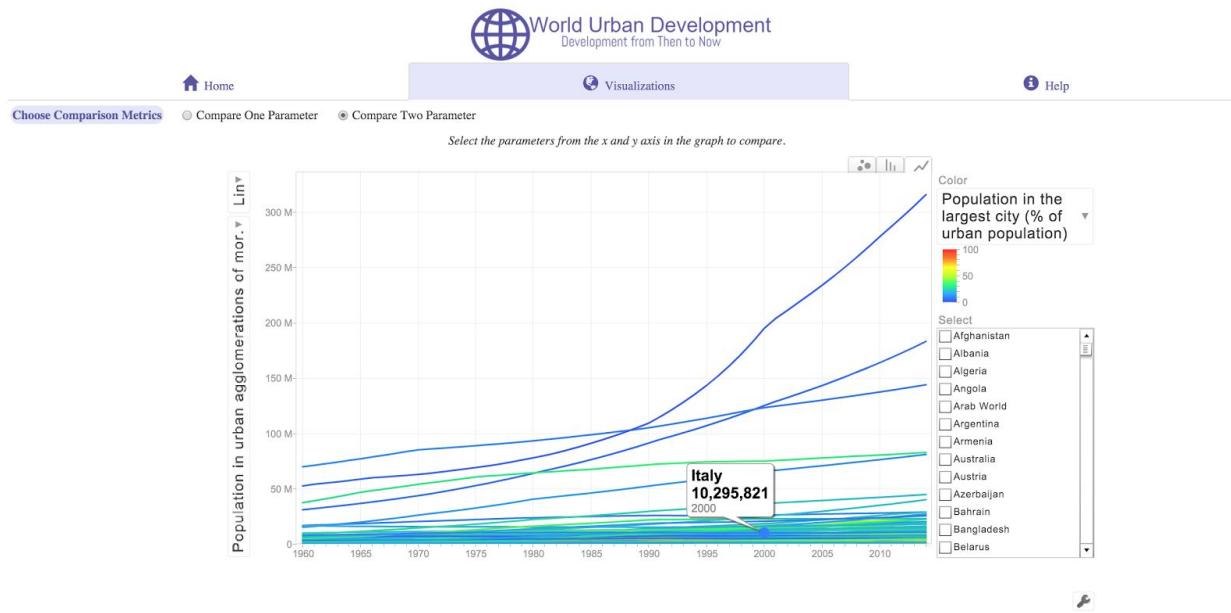
Dynamic motion charts based on bubble visualization, taking two parameters for comparison, which change over time with a built-in auto play feature to visualize the trend in urban development. Users can also control the auto play speed or they can manually slide through the years of interest. It shows an interactive exploration and visualization of longitudinal multivariate data in the form of bar chart and line chart. The application allows to change the visualization color on demand.











**How to Visualize One Parameter Comparison**

- Go to Visualizations Tab and select "One Parameter Visualisation" radio button
- Choose required Year and a Parameter

A world map would be displayed based on the selected parameter and year

Choose required Countries from the world map by holding Shift button and click

Shift + Click on countries to compare

1964 Population in the largest city (% of urban population)

0 25 50 75 100

- 6 different parameters graphs are plotted.

**How to Analyze One Country Parameter**

**How to Visualize Motion Graph**

### Gaps between specification and implementation of Beta release:

All the specifications mentioned in requirements document for Beta release has been met completely. Based on the feedback of client and Alpha release, new features like small multiples with linking and brushing, as depicted in “compare one parameter”, were added to make user experience painless and effortless. We also added the feature of sync tooltip so that comparison amongst countries for various parameter can be done very easily. After getting more knowledge from tufte’s rules for better design, we removed the legends(‘chartjunks’) from the graphs and made tooltip take care of it.

**Beta Testing Tasks:**

1. For the year “2013”, compare the countries “Brazil, India, Russia and China” for a single parameter: “Population in largest city”, from a map and tell
  - a. Which country was having maximum “urban population” in “2001”
  - b. Also tell, whether true or false, if the population density of that country was in the range between 100 and 150.
2. For the single parameter “Population in urban agglomerations of more than 1 million (% of total population)” in the year “2013” and for the countries, “Australia, South-Africa, Argentina and Canada”, and answer:
  - a. Which country had maximum “population density” in the year “2002”
  - b. Also tell, which country had maximum “population in the largest city” for the same year
3. Compare and analyze the trend among countries taking 2 parameters namely “population in largest city” and “Urban Population(% of total)” as axis elements, select the countries “Afghanistan, Argentina, China, France, India, Japan”
  - a. What was the Population in the largest city and the corresponding Urban population % in the year “2009” for the country “India”.
  - b. Now compare “Urban Population” with “Population in urban agglomerations of more than 1 million (% of total population)” and tell what is the value for “Urban Population” for “Japan” in “2014”

### Beta Testing Questionnaire:

1. What were the 3 features that you liked and disliked about the website?
2. How easy was navigation among various pages on a scale of 10 with 10 being very easy? And how helpful was the description on home while performing tasks on a scale of 10 with 10 being very informative.
3. On the scale of 10 with 10 being very easy, how easy was it to accomplish given tasks?
4. On a scale of 10 with 10 being less cognitive load, how would you grade the website on cognitive load on user?
5. On a scale of 10 with 10 being effective, how effective were the color schemes while data representations?
6. How was overall UI experience of the website?
7. What would be your most frequently used task from the website?
  - a. Compare one parameter
  - b. Compare two parameter
8. Was the application content concise but informative?
  - a. 5: Strongly Agree, 4: Agree, 3: Good Enough 2: Disagree, 1: Strongly Disagree
9. Was the tagline informative enough?
10. On a scale of 10, with 10 being very descriptive, how effective did you find the tooltip description provided in all the graphs?
11. On a scale of 10, with 10 being very user friendly, how user friendly was the zoom feature to use in the graphical representation?

#### Participant #1:

1. Liked: arrangement of small multiples charts, synchronized tooltip, motion chart description and help section.
2. 10/9
3. 8
4. 9
5. 10
6. Website interface is very easy to use, everything is easily accessible, and linking of tooltip was impressive
7. Compare Two parameter
8. 5
9. It gives a small hint of what webpage does.
10. 9
11. 10

#### Participant #2:

1. Liked: UI representation, Color scheme of graphs, help section  
Improvement: Reload of the motion graph on when changing tabs.
2. 10
3. 6-7
4. 9

5. 10
6. Liked all the graphical representation and sync tooltip. Reload of motion chart on changing tabs mad user selection to null, maybe change that.
7. Compare one parameter
8. 5
9. -
10. 9
11. -

**Participant #3:**

1. Application was intuitive to use, Clear Tabs, Interface with no scrolls
2. 10
3. 9
4. 10
5. 9
6. Good
7. One Parameter Comparison with linked views.
8. 5
9. Yes
10. 10
11. 9

### Beta Testing Analysis:

Parameters	Tasks	Participant 1	Participant 2	Participant 3	Success %
Task Success	Task 1	100%	100%	100%	100%
	Task 2	100%	100%	100%	100%
	Task 3	100%	70%	100%	90%
					Avg. time to complete each task
Time Taken (in sec)	Task 1	109	134	120	121
	Task 2	73	78	110	87
	Task 3	172	213	183	190
	Total time to complete all tasks	354	425	413	
					Task errors
Errors	Task 1	0	0	0	0
	Task 2	0	0	0	0
	Task 3	0	2	0	2
	Total errors	0	2	0	2
Participant#1 had tested alpha release					
Leanability Analysis	Motion chart usage was improved significantly. User remembered where to select the x-axis and y-axis, which he faced problem with the last time, and changed the axis within 10 seconds of loading the motion chart.				
	User was able to remember in 5 seconds how he selected multiple countries from the map last time.				

### Participant's Feedback:

1. Liked the interface as not much traverse was required.
2. Liked the shared tooltip on all graphs.
3. Transition from one parameter to two parameter was smooth.
4. Lot of useful information available on same page and no traverse required to get new information.
5. Motion chart reloads on change of tabs each time.
6. Help section provides all the information required to perform visualization
7. Video tutorial on home page also provides everything site has to offer.

### Observations:

1. Liked the change in the look and feel of the webpage. - Easy traverse and less options to choose from.
2. Losslessness significantly reduced from last release as user didn't get confused how to compare single and multiple parameters.
3. One of the new users faced difficulty in using motion chart.
4. One of the users used the sync tooltip efficiently and got the answers for the tasks by efficiently using sync tooltip. The user hovered on one graph and found the answer from other graphs.
5. Old user was able to recall map based visualization when using compare one parameter feature and responded very quickly in using. He also liked having so many graph on same page with sync tooltip.
6. Play back feature was attractive and the user played it continuously.

## Public Release - Final Demo Report

This section will briefly explain the current status of the project and the instructions that will have to be followed to run the project

### Final Demo Link

#### Final Demo Screenshots:



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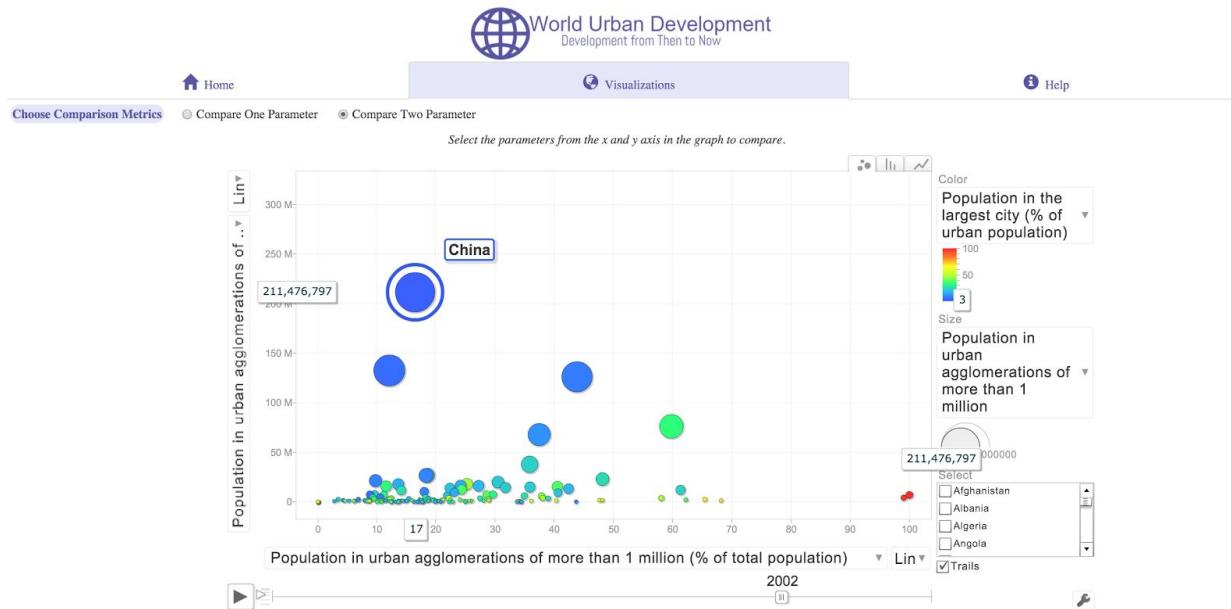
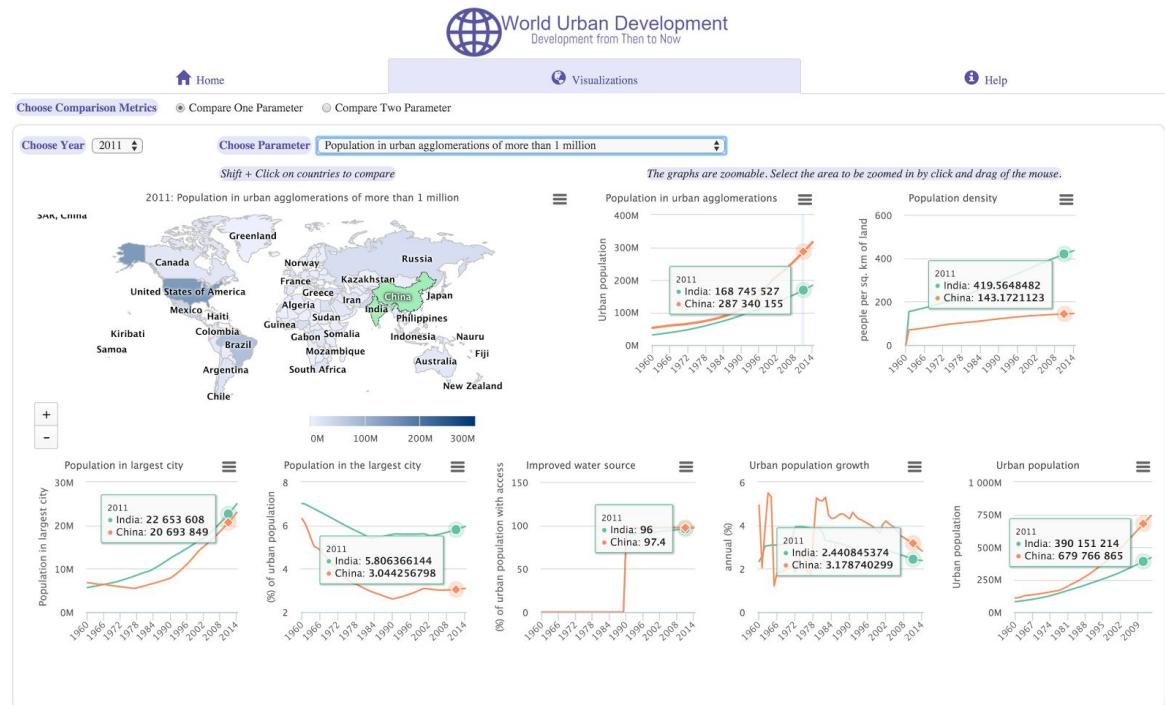
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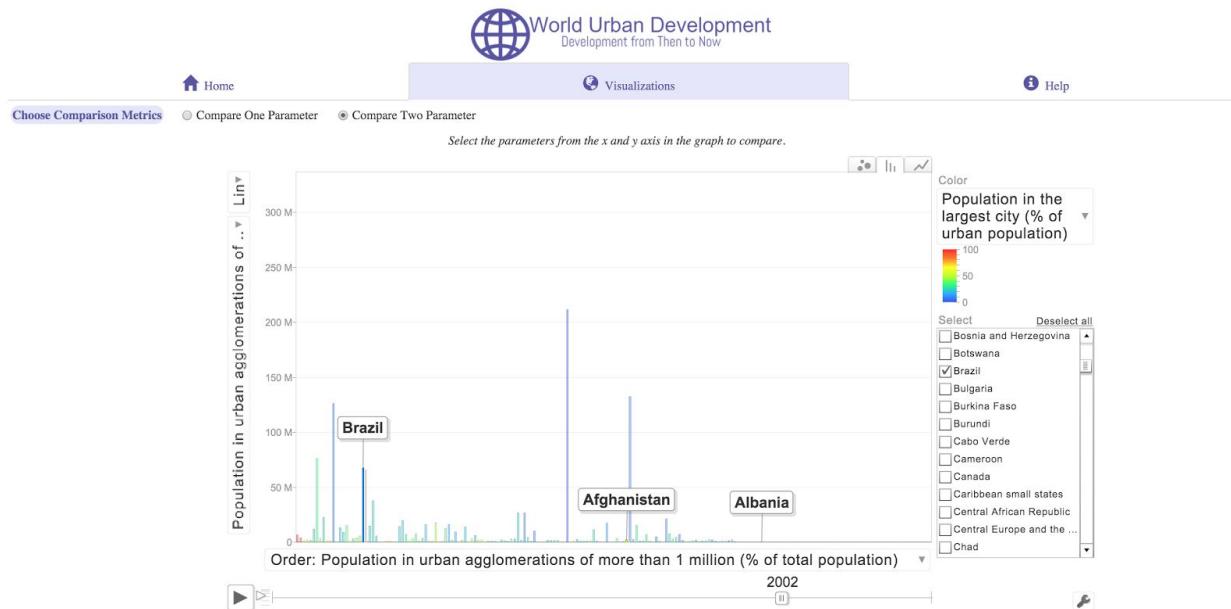
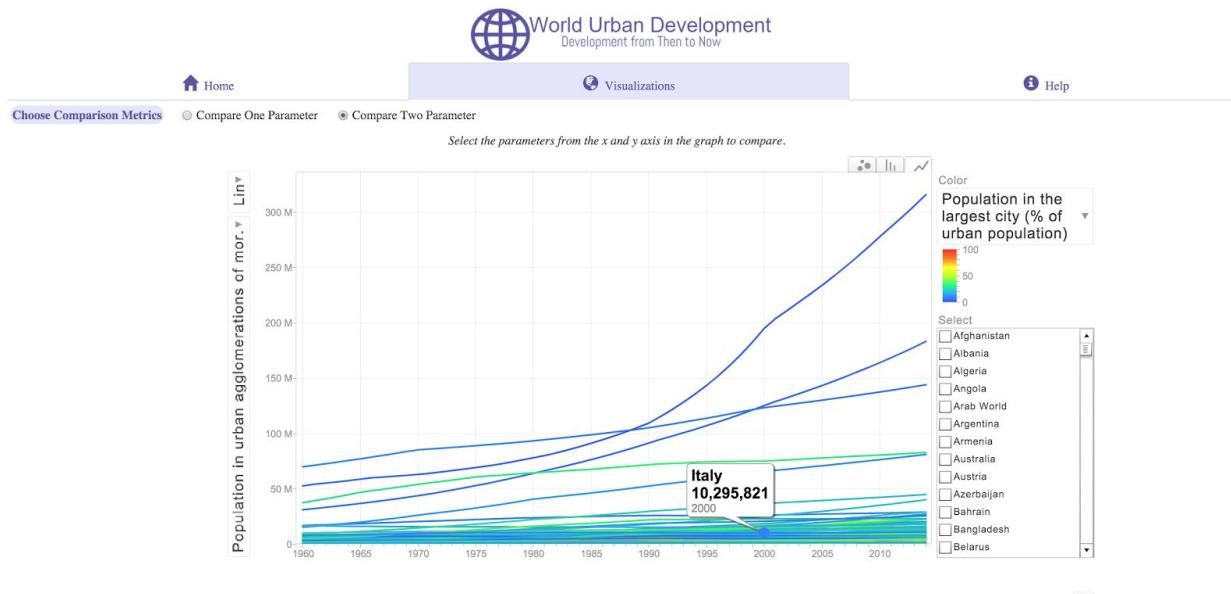
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- 6 different parameters graphs are plotted.

**How to Analyze One Country Parameter**

**How to Visualize Motion Graph**

## What are we most proud of:

1. We were able to exceed client expectations.
2. We used our HCI skills to understand real requirements of client and we were able to come up with better visualizations.
3. Implemented small multiples graph incorporating brushing and linking features.
4. Motion graph with play/pause functionality.
5. We were able to incorporate tufte's law of removing chartjunks and made tooltip more intuitive.
6. Followed Visual encoding and perception concepts to deliver a high quality user friendly project.

## What we learnt from client testing:

1. Client had enough **domain knowledge** (compared to Beta release testers), he was able to perform the tasks much faster and without any error.
2. Client did not use **help page** much in the Beta release testing, which helped us learn that one time interaction(alpha release testing) of the client with the website gave him enough knowledge on how to use the website.
3. **Horizontal tab** feature was more clear with optimized space usage. (compared to proposed vertical tab layout).
4. We learnt that client used '**compare one parameter**' more number of times as it gives him multiple important comparison metrics on the same page.

## Client Feedback:

1. Client was impressed with the **front end user interface** as the information was well structured and categorised and was happy to see that all his requirements were met.
2. He liked the '**compare one parameter**' implementation as it solves his problem of comparing multiple countries for multiple parameters simultaneously.
3. He also liked the **visual encoding** for comparing 2 parameter simultaneously and was happy to use playback functionality.
4. He liked the color scheme for interface and the graphs, and space utilization of the webpage.

## What do we do differently next time

### 1. *Information gathering:*

Spend some more time in information gathering and get a very good idea of client's requirement for the project.

## 2. Prototyping:

Better prototyping in the initial phase after establishing the correct requirements of the client. Follow parallel prototyping approach, keeping in mind the designs principles learnt from tufte's reading and fitt's law and various other techniques like small multiples, linking and brushing etc., and narrow down to a design that best addresses the client's needs.

### Client Testing Tasks:

The client was asked to complete the same task as the Beta testing tasks.

### Client Testing Analysis:

Parameters	Tasks	Client	Success %
Task Success	Task 1	100%	100%
	Task 2	100%	100%
	Task 3	100%	100%
Time Taken (in sec)	Task 1	99	
	Task 2	73	
	Task 3	142	
	<b>Total time to complete all tasks</b>	314	
			<b>Task errors</b>
Errors	Task 1	0	0
	Task 2	0	0
	Task 3	0	0
	<b>Total errors</b>	0	0
<i>Client had Tested Wizard-of-Oz and Alpha release</i>			
Leanability Analysis	Client was able to open 'compare one parameter' and generate map for specific parameter within 7 seconds after reading the task and generated graphs <i>immediately*</i> for all the countries mentioned in the task.		
	Client was able to select required parameter for motion chart within 5 seconds and started selecting the countries from the selection area <i>immediately*</i> .		

\*immediately → as soon as the parameters were set, without wasting time, client started selection of countries

## Instruction for running application

### Project Repository:

[https://github.com/cs522fall2015/CS522\\_Fall2015](https://github.com/cs522fall2015/CS522_Fall2015)

### File Description:

index.html → Project HTML file.

js → Folder containing all javascript files and json data required by application.

css → Folder containing all custom style sheets and Bootstrap.css

fonts → containing fonts used in the application

img → Folder containing internal images required for the application

### External Libraries Used:

**Highcharts** → A charting library written in pure JavaScript, to develop interactive visual informations.

**Google Chart** → A Flash based Google API to develop interactive motion charts and custom views.

**Angular.js** → javascript library to achieve dynamic data binding and manipulate DOM elements.

**jquery** → javascript library to handle user inputs, animations and combine with css to provide good UI.

**Bootstrap CSS** → CSS framework to achieve consistency and responsive screen design and layout.

### Download/Installation:

1. Clone the folder “Folder\_Visualization” from github link:

[https://github.com/cs522fall2015/CS522\\_Fall2015](https://github.com/cs522fall2015/CS522_Fall2015)

2. Download Node.js or any equivalent server if not available in user machine.
3. Install Node.js from terminal/command prompt.
4. Start the server by typing http-server and click enter.
5. Open the browser and go to localhost:8080/index.html.