

Development of the Web Service «Analysis of Demographic Indicators of the Region»

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ABSTRACT

This paper is devoted to the development of the "Analysis of demographic indicators of the region" web service project. Within the framework of this project, a study of the subject area, a review of existing solutions was performed, the structure of a web service was determined, a comparative review of methods and development tools was performed, a development tool was selected, a web service was designed and created. This application will enhance the efficiency of access to demographic data for the Republic of Buryatia, as a special feature, it shall be noted the clarity of the formalization of information both in tabular and graphical form. The study of demographic processes in society using a web service will make it possible to build mathematical models on the basis of which it is possible to obtain long-term forecasts of demographic indicators.

Keywords: *web service, website development, demographic indicators, visual data representation, SW design*

1. INTRODUCTION

Currently, the presentation of data is moving out of the format of tabular values, more and more graphs and pictures are used to represent data. Developing a dynamic map to represent demographic data shall facilitate the work of decision-makers in government services, as well as in other industries.

It was known from the start that politicians need good data to make smart decisions. And that interpreting geographic data on maps was critical to finding solutions to our most difficult problems. The development of an intuitive web service for politicians, business leaders and researchers to quickly visualize and understand the community across the Republic of Buryatia has accelerated the search for the necessary data.

The task consists in normalizing and making a web service for quickly understanding and analyzing data that is collected from different sources. The service offers access to this data through an interactive mapping and analytics platform.

A feature of the web service is that the database has records about the entire Republic of Buryatia and all information that is issued to the user can be viewed both in tabular and graphical form without any particular difficulties. The convenience of downloading data, including from the website of the Territorial Body of the Federal State Statistics Service for the Republic of Buryatia, makes the web service convenient to use [11].

The relevance of this work is due to the fact that a detailed study of the composition of the population and demographic processes is an important factor in assessing the socio-economic development of the region. The study of the demographic processes taking place in society makes it possible to build their statistical and mathematical models,

on the basis of which it is possible to obtain forecasts of demographic indicators [9].

1.1. Overview of available solutions

To create a high-quality and usable service, it is necessary to study the existing solutions that are presented in the product market.

The following web services were analyzed during the review of available solutions for analyzing demographics:

- Federal State Statistics Service website (<https://www.gks.ru/>);
- Country Meters website (https://countrymeters.info/ru/Russian_Federation/);
- World o Meters website (<https://www.worldometers.info/>);
- Justice Map website (<http://www.justicemap.org/>);
- Policy Map website (<https://www.policymap.com/maps>).

A brief review of these web services showed that the reviewed sites generally provide functionality in two ways:

- Providing data on standard demographic indicators;
- Viewing relevant information, including news.

Most of the sites reviewed are built on a similar principle. It shall be noted the high interactivity of the interfaces of the sites considered, most of the pages are saturated with various elements of interaction with users. This provides for the more detailed and accurate control of the required data. To compare web services, a comparison table was compiled for various characteristics (Table 1).

Table 1 Overview of ready-made solutions

Web service and characteristics	Federal State Statistics Service	Country Meters	World o Meters	Justice Map	Policy Map
Data older than 1990	-	-	+	-	-
Russian language service	+	+	-	-	-
Variety of indicators	+	-	-	-	+
Using third-party services to display data	+	-	-	-	-
Using charts as a map	+	-	+	+	+
Sponsoring	+	+	-	+	+

In the course of a comparative review of ready-made solutions, one can observe the main disadvantages of ready-made solutions. Of the solutions presented, it is necessary to single out the federal state statistics service for its functionality and timely information update. From the presented solutions, the web service of the Federal State Statistics Service is more relevant and functional.

1.2. Functional requirements for the site

Following requirements for the site functionality are stipulated:

- Have a convenient navigation system;
- Provide an opportunity to demonstrate demographic information to users.

Following requirements for the data display are stipulated:

- Simple interface for selecting demographic indicators;
- Display data: using a map, line graphs, tables, bar chart.

Following requirements for the provided data are stipulated:

- All data shall be taken from official sources;
- The data shall not be corrupted.

1.3. Web service prototype

A prototype to be followed has been developed to simplify the development of a web service. The prototype indicates where this or that information shall be located. An example of the developed template is shown in Figure 1.

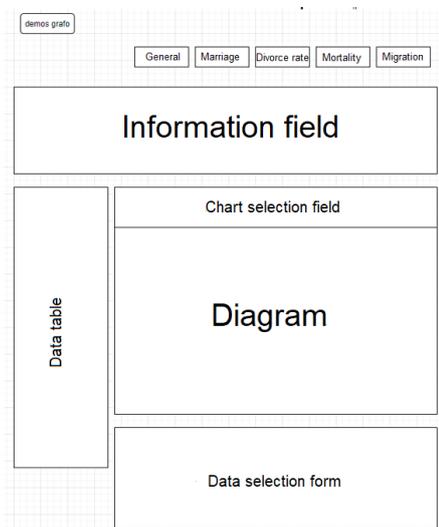


Figure 1 Example of a page layout template

The template shows that the page is divided into several main areas:

- Transition fields. The fields "General", "Marriages", "Divorces", "Mortality", "Migration" are the header of the site, they shall be used to switch between the types of demographic indicators;
- Information field. In the course of the promotion and development of the web service, it is advisable to leave space for the news feed, in which one can place any necessary information that may be useful to the user, and this field can also be used to place advertising banners to attract investors or sponsors;
- Diagram. The chart field is the place where the graphical representations of the database tables will be displayed, here the user can see the data he requested in a graphical representation;
- Data selection form. Items for filling, when entering which the user receives the material he needs.

2. METHODOLOGY OF THE STUDY

2.1. Development tool selection

The Open Server Panel software environment was used to write the website.

Open Server Panel is a portable server platform and software environment designed specifically for web developers, considering their recommendations and wishes. The software complex has a rich set of server software, a convenient, multifunctional well-thought-out interface, and has powerful capabilities for administration and configuration of components. The platform is widely used for the development, debugging and testing of web projects, as well as for providing web services on local networks.

Although initially the software products included in the complex were not developed specifically to work with each other, such a bundle has become very popular among Windows users, primarily due to the fact that they received a free software package with reliability at the level of Linux servers.

Convenience and ease of management have established the Open Server software environment as a first-class and reliable tool that a web developer needs.

PHP is a widely used open source general-purpose programming language. PHP is specially designed for web development and its code can be embedded directly into HTML. PHP scripts run on the server and generate HTML that is sent to the client.

MySQL is one of the most popular and most widely used database management systems on the Internet. It is not designed to work with large amounts of information, but its use is ideal for Internet sites, both small and large enough.

Dbdesigner is a free full featured visual database scheme designer.

JavaScript is a programming language that allows to implement complex web page behavior. Every time one sees a web page, it not only displays static content but also does more - displays content updates in a timely manner, displays interactive maps, 2D/3D animations, scrolls videos, etc.

2.2. Choosing a visual display for demographic data

The indications for the program are taken from the database, therefore, for the development, a library was required, associated with demonstrating data in the form of diagrams. For this function, 6 libraries have been allocated that are most suitable for this role.

1. D3.js

D3.js is a JavaScript library for data-driven document management. D3 helps “bring data to life” with HTML, SVG and CSS. D3.js provides powerful rendering components and a data-driven approach. Unlike many other JavaScript libraries, the library is not delivered with in advance created schedules directly from a box [4].

One of the biggest drawbacks of this library is that D3.js is incompatible with older browsers like IE8.

The operation of this library is shown in Fig. 2.



Figure 2 How the D3.js library works

2. Chartkick

Chartkick - JavaScript library for drawing charts/schemes in Ruby applications. Chartkick is mainly intended for charting, but it has quite good capabilities for creating geo charts images based on SVG format. The library does not contain its own website, it can be fully downloaded from the GitHub resource, so Fig. 3 shows an example of the library’s work, provided by the developer on a third-party site [2].



Figure 3 How the Chartkick library works

3. amCharts

amCharts is a collection of software libraries and tools for the data visualization on the Internet.

The amCharts JavaScript library supports classic charts such as Line, Area, Column, Bar, Pie, XY, Scatter, Candlestick, and OHLC, as well as more exotic charts such as Gauges, Funnels, Gantt, Chord and Sankey, TreeMap, and fully interactive adaptive maps of the world or local country. Fully functional products are available free of charge (with a small backlink) for any type of use, as well as in paid commercial form for all types of use cases [1].

amCharts uses SVG for rendering, which only works in modern browsers. Charts may not display correctly in IE versions below 9.

The free version leaves a link to their website at the bottom of every graph generated. AmCharts commercial licenses are more expensive than most paid libraries on the market. The library is shown in Fig. 4.

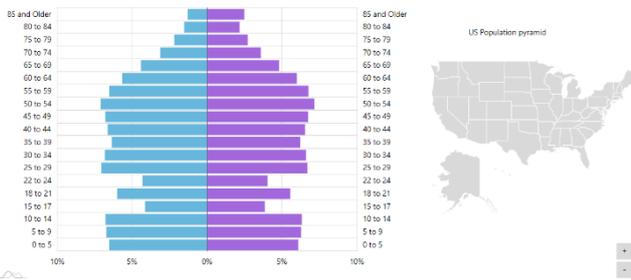


Figure 4 How the amCharts library works

4. Google Charts

Google Charts is one of the simplest JavaScript libraries applied to create charts easily and quickly. Google Charts provides many pre-built charts that can be used for free during software development [3].

Google charts also has a lot of configuration settings that help change the look of the chart. Charts are rendered using HTML5/SVG in order to ensure cross-browser compatibility and cross-platform functionality.

Google Charts contains VML to support older IE versions. Therefore, the Google Charts library runs on all browsers. Fig. 5 shows how the Google Charts library works.

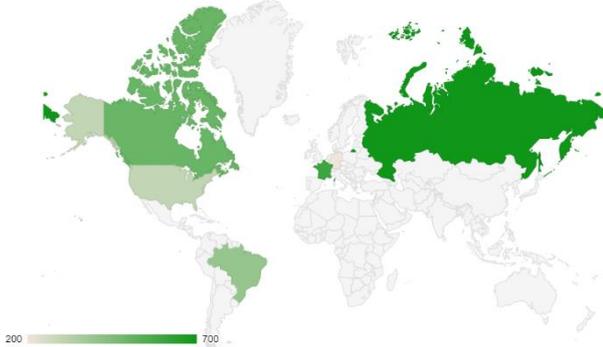


Figure 5 How the Google Charts library works

5. Polymaps

Polymaps creates images and vector maps using SVG. It is a mapping library aimed directly at audience requiring data visualization [6]. This is a great resource that offers a unique approach to the design of the cards they create. The work created using the Polymaps library is shown in Fig. 6.

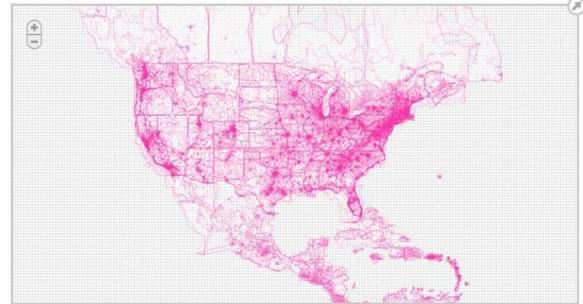


Figure 6 How the Polymaps library works

6. Kartograph

Kartograph is a simple and lightweight framework for creating interactive map applications without Google Maps or any other mapping service. It was created with the needs of designers and data journalists in mind [5].

The work of the site using the Kartograph library is shown in Fig. 7.



Figure 7 How the Kartograph library works

It is necessary to conduct a comparative review to select the most suitable libraries. The libraries are compared in Table 2.

Table 2 Comparison overview of libraries for creating diagrams

Library	Not compatible with older browsers	Shareware components	Flexible use of the library	A large amount of documentation on the library
D3.js	+	-	+	-
Chartkick	-	-	-	+
amCharts	-	+	+	+
Google Charts	+	-	+	+
Polymaps	-	-	-	-
Kartograph	-	-	-	-

In the course of a comparative review of the libraries, it was decided to use amCharts and Google Charts due to the ease of handling them and the large database of examples of working with them.

3. RESULTS OF THE STUDY

After the analysis of the subject area, a comparative review of tools for developing web services, we will start designing and creating.

3.1. Database development of a web service

In the course of implementing the web service, the "rb" database was created in MySQL. The technical tables that are required for the programs to work are shown in Fig. 8.

<input type="checkbox"/>	rn	★	📄	📁	🔍	🗑️	✖️
<input type="checkbox"/>	type_dock	★	📄	📁	🔍	🗑️	✖️
<input type="checkbox"/>	type_nas	★	📄	📁	🔍	🗑️	✖️

Figure 8 DB technical tables

Table "rn" is a repository with the names of the regions of the Republic of Buryatia, it is shown in Fig.9.

Options				id	name	dop
<input type="checkbox"/>	🔍	🗑️	✖️	1	Баргузинский район	bargyzin
<input type="checkbox"/>	🔍	🗑️	✖️	2	Баунтовский эвенский район	bayntovski
<input type="checkbox"/>	🔍	🗑️	✖️	3	Бичурский район	bichyra
<input type="checkbox"/>	🔍	🗑️	✖️	4	Джидинский район	dgida
<input type="checkbox"/>	🔍	🗑️	✖️	5	Еравнинский район	eravninsk
<input type="checkbox"/>	🔍	🗑️	✖️	6	Заиграевский район	zaigraevsk
<input type="checkbox"/>	🔍	🗑️	✖️	7	Закаменский район	zakamensk
<input type="checkbox"/>	🔍	🗑️	✖️	8	Иволгинский район	ivolga
<input type="checkbox"/>	🔍	🗑️	✖️	9	Кабанский район	kabansk
<input type="checkbox"/>	🔍	🗑️	✖️	10	Кижингинский район	kizhinginski
<input type="checkbox"/>	🔍	🗑️	✖️	11	Курумканский район	kyrymkanski
<input type="checkbox"/>	🔍	🗑️	✖️	12	Кяхтинский район	kuahta
<input type="checkbox"/>	🔍	🗑️	✖️	13	Муйский район	myiski
<input type="checkbox"/>	🔍	🗑️	✖️	14	Мухоршибирский район	myhorshibir
<input type="checkbox"/>	🔍	🗑️	✖️	15	Окинский район	okiniski
<input type="checkbox"/>	🔍	🗑️	✖️	16	Прибайкальский район	pribaikalski
<input type="checkbox"/>	🔍	🗑️	✖️	17	Северо-Байкальский район	severo-Baikalski
<input type="checkbox"/>	🔍	🗑️	✖️	18	Селенгинский район	selenginski
<input type="checkbox"/>	🔍	🗑️	✖️	19	Тарбагатайский район	tarbagatai
<input type="checkbox"/>	🔍	🗑️	✖️	20	Тункинский район	tynka
<input type="checkbox"/>	🔍	🗑️	✖️	21	Хоринский район	horinsk
<input type="checkbox"/>	🔍	🗑️	✖️	22	Улан-удэ	ylan-yde
<input type="checkbox"/>	🔍	🗑️	✖️	23	Бурятия	byratia

Figure 9 Technical table with the regions of the Republic of Buryatia

The "type_dock" table is a repository with types of demographic data, it is shown in Fig. 10.

Options					
←T→	▼	id	type	dop	
<input type="checkbox"/>			1	Marriages	marriage
<input type="checkbox"/>			2	Divorce	razv
<input type="checkbox"/>			3	Fertility	rozdaemost
<input type="checkbox"/>			4	Mortality	smertnost
<input type="checkbox"/>			5	Migration	migration

↑ Select all

Figure 10 Technical table with possible Demographic Indicators

The "type_nas" table is a repository with population types, it is shown in Fig. 11.

Options					
←T→	▼	id	type	dop	
<input type="checkbox"/>			1	Entire population	all
<input type="checkbox"/>			2	Urban population	sity
<input type="checkbox"/>			3	Rural population	village

↑ Select all

Figure 11 Technical table with possible population types

Moreover, tables with the indicators are used for the implementation of the project. Such tables have a different look.

Technical tables play an important role in the operation of a web service, therefore, their presence in the database is extremely necessary.

3.1. Web service navigation

Navigation is an important design element that helps the user quickly access the parts of the site the user needs. When visiting the site for the first time, the user sees a horizontal menu that is suitable for sites with a small number of sections. The navigation menu developed for the web service is shown in Fig. 12.



Figure 12 Navigation menu

It has the following tabs:

- General;
- Marriages;
- Divorces;
- Mortality;
- Migration.

These tabs show the different types of demographic indicators and do not differ graphically from each other.

Below is a place for a news feed, in which any necessary information that may be useful to the user may be placed or used to place advertising banners to attract investors.

During the operation of the web service, the image can be changed to any other.

At the first entrance to the site, if the user tries to open the "Map" or "Diagram" item, in order to avoid system breakdown, the user will be provided with data for 2016, therefore, the map of Buryatia will look as shown in Fig. 20, and the bar chart will look like Fig. 13.

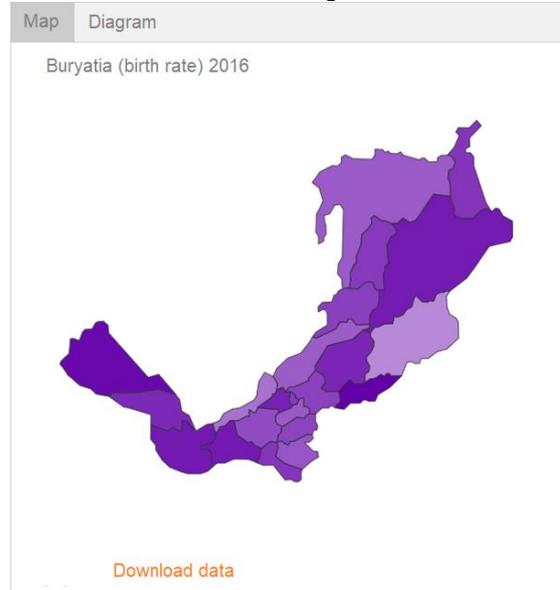


Figure 13 Dynamic map of the Republic of Buryatia

Moreover, in order to avoid the case of an error with the first entry to the site, the tabular data view also takes values for 2016. This will change the side menu as shown in Figure 14.

User navigation on the "General" tab occurs using the form shown in Fig. 15.

The user navigates through individual regions using the form (Fig. 16) on the pages of demographic indicators.

District	Value
Баргузинский район	16.3
Баунтовский Эвенский район	19.3
Бичурский район	14.4
Джидинский район	19.4
Еравнинский район	10
Заиграевский район	16.1
Закаменский район	19.4
Иволгинский район	18.8
Кабанский район	12
Кижингинский район	21.6
Курумканский район	16.7
Кяхтинский район	17
Муйский район	17.1
Мухоршибирский район	15.8
Окинский район	20.8
Прибайкальский район	13.7
Северо-Байкальский район	13.9
Селенгинский район	15.2
Тарбагатайский район	14
Тункинский район	18.1
Хоринский район	18.4
Улан-удэ	16.6

Figure 14 Side menu displaying table values

Enter the data

Year

Select population
 Population

Select an index
 Index

Download

Figure 15 Form for selecting demographic indicators on the "General" tab

Enter the data

Select population
 Population

Select a district
 District

Download

Figure 16 Form for selecting demographic indicators on the remaining tabs

Tables are added to the database through the context menu, which is available for the service administrator. The function to delete tables is also located in the context menu of the administrator.

Later, during the modernization of the web service, its possible functions can be expanded and modernized without any problems.

To graphically represent the demographic indicators of individual regions, two types of diagrams are used, linear (shown in Fig. 21) and step (shown in Fig. 22).

3.2. Dynamic region map module

The development of a dynamic map module for visual presentation of indicators took a lot of time due to the small number of analogs, the small amount of literature, as well as the transfer of data from official sources for their subsequent use. The final version of such a map represents all regions of Buryatia for 2020, the color saturation of which is determined by the largest demographic indicator. An example of the program is shown in Fig. 19.

During testing of libraries from different platforms, it was decided not to use third-party resources, due to the fact that ready-made libraries are not suitable for the implementation of the conceived project due to their complex functionality and inconvenient editing of the map. In the development process to create a map layout using the program Inkscape which is freely available.

The program saves the created image using path d commands, which is not suitable for us for use, convert path

d to points using the converter and get a polygon suitable for use in the program. The converted polygon is as follows:

```
<g id="cam">
  <polyline class="st0" points="400.000 515,800,
  400.400 503.300, 404.400 505,400">
</g>
```

Using the converter, it is necessary to transform 21 polygons, after which we combine them into one div class in which the svg image itself will be located. The map of Buryatia, which was obtained during the transformations, is shown in Fig. 17.



Figure 17 Map of Buryatia without data

After creating the map, a script handler for targeting the polygon was created to highlight the data received from the server, as well as dynamically change the color of the map. To do this, an array is created that stores the region name, region code, and demographic indicator.



Figure 18 Natural population growth in the Republic of Buryatia in 2016

The color saturation of the polygon is determined by the largest demographic indicator, therefore, in Fig. 18 and Fig.

19, one can observe the difference between the original data and the distorted in which for one of the regions the indicator was increased by 50, it shall be taken into account that the data are recorded as a percentage.



Figure 19 Distorted population growth in the Republic of Buryatia for 2016

The use of a script written during the development of a web service reduced the complexity of the subsequent operation, and also made it easier to edit and modernize to enhance the site performance.

3.3. Chart data presentation module

For the diagrammatic presentation of demographic indicators of individual regions, as well as the entire Republic of Buryatia, three types of diagrams are used: column, linear, and stepped. They are shown in Fig. 20 which presents data for 2016, Fig. 21, and Fig. 22 showing all-time birth rate information.

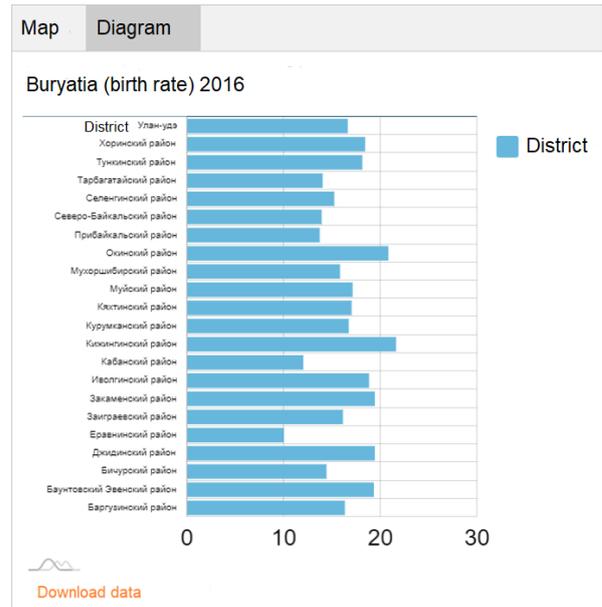


Figure 20 Bar chart

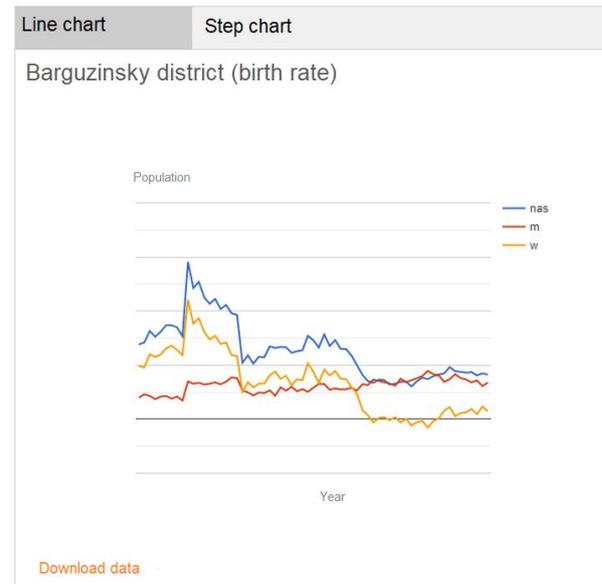


Figure 21 Line chart

The above charts were chosen for the web service because of their graphical forms. They can easily accommodate a large amount of information without stretching the charts or transferring data to other pages.

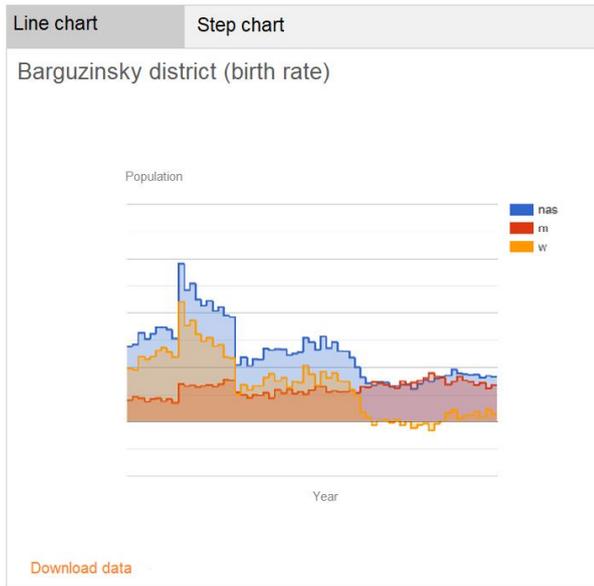


Figure 22 Stepped diagram

4. DISCUSSION OF RESULTS

Within the framework of this project, work was performed to create the "Analysis of demographic indicators of the region" web service. For this, a conceptual model of the future web service was created, a website prototype was created, and navigation was developed.

AmCharts, Google Charts and Open Server Panel are selected based on a comparative overview of various visualization technologies and development tools.

To store the web service data, a database was designed and built using PHP My Admin.

The next step was the development of the web service itself, including the implementation of visual means of displaying information based on the selected technologies.

To check the web service, test documentation was written, during the execution of which there were no violations of the ToR, graphical errors or errors in the functionality of the program, which means that the web service performs its functions and is operational.

Currently, the market for web services dedicated to demographic indicators is not fully formed, therefore this web service may be of interest to consumers along with large market representatives. The current version of the program is not final, further work is underway on the web service, at the moment a large number of modifications are being considered in terms of development and modernization to obtain a more suitable result.

Partially the results of the work were reported in the following publications [7], [11], [12].

5. CONCLUSION

In the course of this work, a conceptual model for developing a web service, logical and physical models of the service database were designed.

On the basis of the created models, the "Analysis of the demographic indicators of the region" web service was developed. During the project, a database was created using MySQL. The site interface is designed considering the requirements for user interface ergonomics. 10 test plans were developed, during the testing the program showed its efficiency, all test requirements were met, the tests were positive and corresponded to the expected results. The work is fully completed and implemented for use at the Department of Informatics Systems.

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