GEODATA SOURCES AND GEOINFORMATION SYSTEMS IN HYDROMETEOROLOGICAL SECURITY

Dariusz DRZEWIECKI, PhD
Collegium Balticum University, Szczecin, Poland

Abstract

A definition of the concept of information was placed in the publication of spatial ata with reference to the hydrometeorological systems covering the country. The next keys to the encryption and transmitting of hydrometeorological measurement were specified in the international system for warning against the dangerous phenomena of the weather. The characteristics of meteorological data they presented were based on the system of weather satellites (circumpolar and geostationary) and of the POLRAD radar system, included in the radar security system of European space. At the end, a few examples were given of geoportals monitoring the state of the natural environment and elements of the ISOK security system, the SMOK system and SSH military system of the Republic of Poland.

Key words: geoportals, spatial, weather information, meteorological telegram, weather satellites, meteorological radars, aerological system, ISOK, SMOK system.

Introduction

In the space around us on Earth, one should interpret all the information regarding the geographical environment and phenomena as spatial information. However, geographic information comes from connecting text information about the object with the place in the geographical space Therefore geoinformation lets us describe geographical situations and situating the inventoried object According to the dictionary, PWN- Geographical Information System: or (*GIS*) is a system

designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data[1]. The acronym GIS is sometimes used for geographic information science (GIScience) to refer to the academic discipline that studies geographic information systems and is a large domain within the broader academic discipline of geoinformatics. What goes beyond GIS is spatial data infrastructure, a concept that has no such restrictive boundaries. GIS can relate unrelated information by using location as the key index variable. Locations or extents in the Earth space–time may be recorded as dates/times of occurrence, and x, y, and z coordinates representing, longitude, latitude, and elevation, respectively. All Earth-based spatial–temporal locations and extent references should, ideally, be relatable to one another and ultimately to a "real" physical location or extent. These key characteristic of GIS have begun to open up new avenues of scientific inquiry.

Chosen Keys for the Encryption of Results of Down-to-earth Hydrometeorological Observation

Both civil and military hydrometeorology, perform the tasks of hydrometeorological cover of society and sectors of the national economy. Meteorological stations test points are acquired from the network and meteorological servicemen (from the air forces). 61 synoptic stations: are doing 24-hour measurements and observation using standard and automatic apparatus. Observation and measurements are performed at closely specified time limits, in the form encrypted of telegrams, directed into interested cells and into the network of the international exchange. Observation at synoptic targets is performed worldwide on the same dates, established according to UTC universal time (Universal Time Coordination)[2]. The

1 Look - //http://encyklopedia.pwn.pl/haslo/systemy-informacji-przestrzennej;3982240.html//.

2 Coordinated Universal Time (French: *Temps universel coordonné*), abbreviated as UTC, is the primary time standard by which the world regulates clocks and time. It is within about 1 second of mean solar time at 0° longitude;[1] it does not observe daylight saving time. It is one of several closely related successors to Greenwich Mean Time (GMT). For most purposes, UTC is considered interchangeable with GMT, but GMT is no longer precisely defined by the scientific community.

main and indirect observation in the international exchange takes place at: 00.00, 03.00, 06.00, 09.00, 12.00, 15.00, 18.00, 21.00, in the domestic exchange - hourly, and always every half an hour at the meteorological service of the air forces. Results of all measurements and observation are sent regularly and additionally documented in daily newspapers of observation.

SYNOP - code with the help of which meteorological observations effected on meteorological stations worldwide are coded. The SYNOP telegram includes: the speed and the direction of the wind, visibility, present weather, recent weather, sky condition, temperature, dew point, pressure.

METAR - format (coded) of report on the weather used in aeronautical meteorology and a weather forecast. METAR is an acronym from METeorological Aerodrome Contango. They are usually sent to METAR hourly by civilian stations; however, military stations are sending METAR telegrams every 30 minutes. A typical METAR contains information about the temperature, the pressure, the temperature of the dew point, the speed and the direction of the wind, fall, cloud cover, height of the cloud base, visibility, but can also contain other information (e.g. state of runways).

STORM - telegram warning, regarding a dangerous phenomenon moving nearby.

AVIO - verbal sign for telegram appeal, regarding disappearance of or ongoing experience of an occurrence.

SHIP - telegram for the encryption of results of observation of the weather from ships. **TEMP - t**elegram for the encryption of results of measurements of the vertical survey of the atmosphere (wind - direction and the speed, characteristics of the humidity of air).

Spatial infrastructure in the exchange data hydrometeorological system

In the course of the last few decades, mankind has achievd a level of technical development enabling remote observation of many occurrences taking place on Earth. The spatial resolution of information delivered by satellites lets the size of meters observe processes occurring in areas. From satellite data, we can obtain information about current weather conditions, and data allowing for the drafting of weather forecasts. From satellites, it is also possible to watch the appearance in the atmosphere of dangerous phenomena, such as the birth of cyclones and the phenomena of accompanying winds, the strength of a hurricane, and systems of weather fronts with stormy cells. The projection of data in the infrared also enables thermal analysis of studied areas and the level of saturating them with steam.

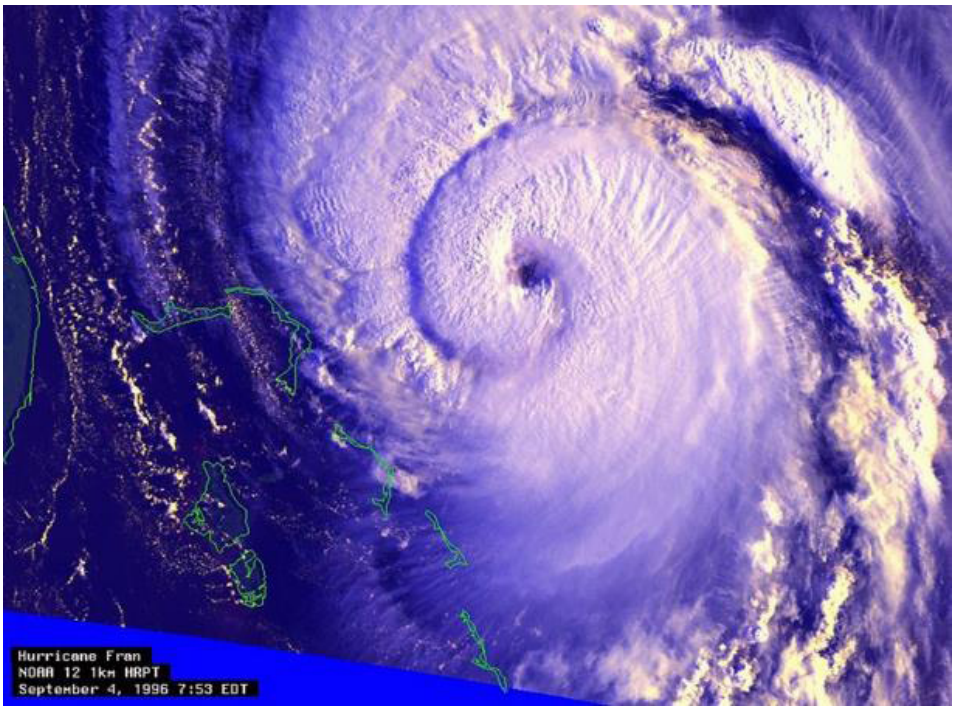
Weather satellites (METEOSAT[3], NOAA[4])

A remote sensing satellite is a modern research technique in development since the 1960s. . At first, examinations were focused on the soundings of the atmosphere, then data transmission from the first weather satellites, all the way through to the creation of systems of geostationary and circumpolar satellites, providing hydrometeorological information in the constant system - twenty-four hours a day. Satellite data is used for the creation of meteorological products. Vivid products are created by different degree of processing - images from individual spectral channels, products with colorful composition , products about meteorological character, as well as the sounding of the atmosphere reproduced in the graphic form -, the stability of the atmosphere and the Satellite data are used to support the weather forecaster. In practice, two systems of weather satellites are being

3 Look - http://www.eumetsat.int/website/home/Satellites/CurrentSatellites/Meteosat/index.html Two generations of active Meteosat satellites, Meteosat First Generation (MFG) and Meteosat Second Generation (MSG), providing images of the full Earth disc, and data for weather forecasts.

4 **National Oceanic and Atmospheric Administration** (**NOAA**), USA.

used – the circumpolar system of weather satellites e.g. NOAA (fig. 1) and the geostationary system of weather satellites e.g. EUMETSAT (fig. 2).



Source: http://www.noaa.gov/.

Fig. 1. Example of a satellite image received from a satellite of the NOAA system

Satellites of NOAA Series (from a historical perspective):

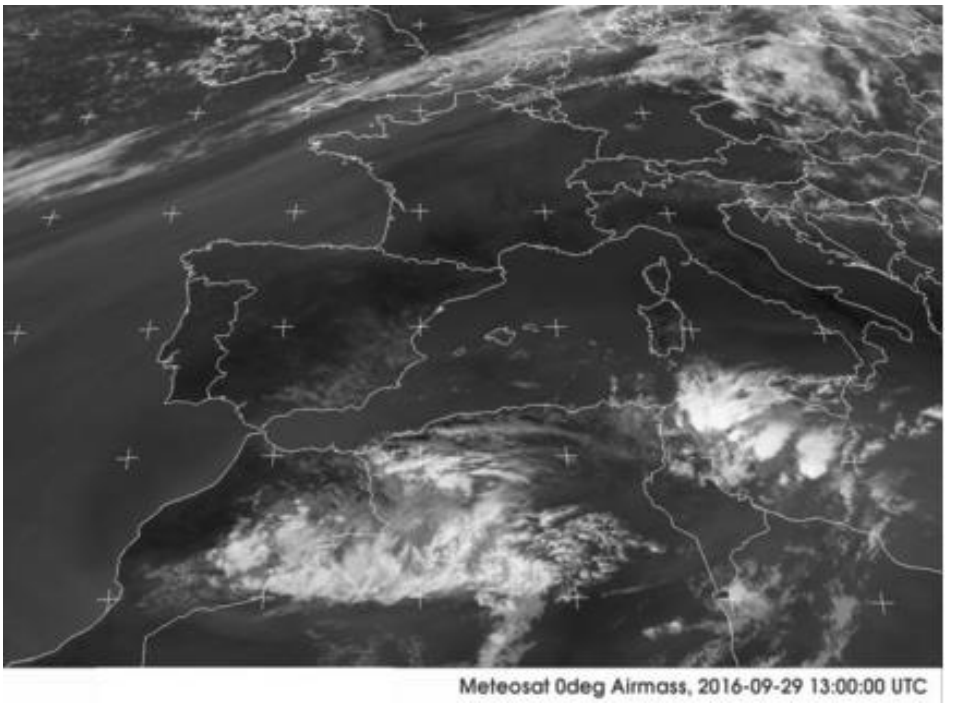
- NOAA 1 (ITOS-A) – start 11.12. 1970, disabled
- NOAA 2 (ITOS-D) – start 15.10. 1972, disabled
- NOAA 3 (ITOS-F) – start 6.11. 1973, disabled
- NOAA 4 (ITOS-G) – start 15.11. 1974, disabled
- NOAA 5 (ITOS-H) – start 29.07. 1976, disabled
- NOAA 6 (NOAA A) – start 27.06. 1979, turned off 31.03.1987
- NOAA B – start 29.05. 1980, turned off
- NOAA 7 (NOAA C) – start 23.06.1981, turned off
- NOAA 8 (NOAA E) – start 28.03. 1983, broke down
- NOAA 9 (NOAA F) – start 12.12. 1984, disabled
- NOAA 10 (NOAA G) – start 17 .09. 1986, disabled

- NOAA 11 (NOAA H) – start 24.09. 1988, disabled
- NOAA 12 (NOAA D) – start 14. 05. 1991, disabled
- NOAA 13 (NOAA I) – start 9. 08. 1993, disabled
- NOAA 14 (NOAA J) – start 30.12. 1994, disabled
- NOAA 15 (NOAA K) – start 13.05. 1998, is sending on the frequency 137,620 MHz
- NOAA 16 (NOAA L) – start 21.09. 2000, finished the mission 9.06.2014
- NOAA 17 (NOAA M) – start 24.06.2002, is sending on the frequency 137,500 MHz
- NOAA 18 (NOAA N) – start 20.05. 2005, is sending on the frequency 137,9125 MHz
- NOAA 19 (NOAA N Prime) – start 6.02. 2009, is sending on the frequency 137,100 MHz

Geostationary weather satellites are controlled by EUMESTAT[5] (METEOSAT) European Organization of the Use of weather satellites, USA (GOES)[6], Japan (MTSAT), China (Fengyun-2), Russia (GOMS) and India (KALPANA).

Their orbits are put in the equatorial sphere at 38500 km. At this height, the speed of the satellite is the same as the speed of the rotation of the Earth, but the satellite immediately on the equator seems to be stationary. This orbit lets the satellite constantly observe the same areas: 42% of the area of land. In order to receive the global report, a net is needed of five or six satellites.

5 Look - http://www.eumetsat.int/website/home/index.html.
6 GOES - NOAA (The National Oceanic and Atmospheric Administration) USA, GOES - Geostationary Satellite Server [http://www.goes.noaa.gov/].



Source: http://www.wetterzentrale.de/.

Fig. 2. Example of a satellite image from a satellite of the METEOSAT system

Satellites of METEOSAT Series (from a historical perspective):

Meteosat satellites of the first-generation (MFG):

- Meteosat-1 1977-1979
- Meteosat-2 1981-1991
- Meteosat-3 1988-1995
- Meteosat-4 1989-1995
- Meteosat-5 1991-2007
- Meteosat-6 1993-2012
- Meteosat-7 1997-2016

Meteosat satellites of the second generation (MSG):

- Meteosat-8 2002-2019
- Meteosat-9 2005-2021
- Meteosat-10 2012-2022
- Meteosat-11 2015

Circumpolar satellites, as the name itself indicates, will move on orbits flying above, or in the vicinity of terrestrial poles. The height of the orbit is 700-900 km above the surface of the Earth. The currency of the Earth is about 100 minutes. Weather satellites on the polar orbit are controlled by the USA (NOAA, QuikSCAT), Russia (Meteor) and China (Fengyun-1). A dozen or so stations receiving weather satellite information are located in Poland (METEOSAT and NOAA):

The Meteorological Office and of water management and satellite research plant in Cracow (all systems of weather satellites),

The Military University of Technology in Warsaw[7] (METEOSAT),

The Institute of Geodesy and Cartography in Warsaw (NOAA),

The Silesian University, Department of earth sciences in Sosnowiec (NOAA),

The Karkonosze Collegium in Jelenia Góra (METEOSAT),

Warsaw University, Department of Geophysics (METEOSAT),

Gdańsk University, Department of Oceanography (NOAA, METEOSAT),

Gdańsk University, Institute of Geography (METEOSAT),

The Maria Curie Skłodowska University in Lublin (NOAA),

Szczecin University (NOAA),

The Main Institute of Forestry (NOAA),

Adam Mickiewicz University in Poznań (METEOSAT).

Radar System of Meteorological Cover (POLRAD)

Poland is creating meteorological POLRAD radars itself from teledetektion ground devices of a few hundred kilometres bringing the monitoring of the structure

7 Look. „Satelitarne obrazy procesów atmosferycznych kształtujących pogodę". Wydawnictwo Naukowe PWN, Warszawa 1999, by editing Czesława Rymarz.

and the migration of meteorological objects in the troposphere within range. These measurements constitute an important source of the input for numerical meteorological and hydrological models. The POLRAD network consists of eight radars (fig. 3) of German production (Gematronik)[8].

Fig. 3. Arranging radars of the POLRAD system

A gradual exchange of radars for radars of a new generation with enhanced measuring possibilities began in 2009. It is possible to obtain radar data information from the sites: [http://meteo.org.pl/radary] - Poland or [http://meteo.org.pl/radar-europa] - Europe. We can track the current water level in rivers, weather phenomena, the pressure distribution and temperatures. The newest satellite images for Europe are at [http://meteo.org.pl/sat]. A single radar is ensuring hydrological and meteorological protection in an area with a radius of 100 - 200 km. The radar cover of the entire area of Poland is possible

8 Selex ES in Germany. Selex ES GmbH has built successful domestic and international export businesses in the fields of Meteorology and Telecommunications.

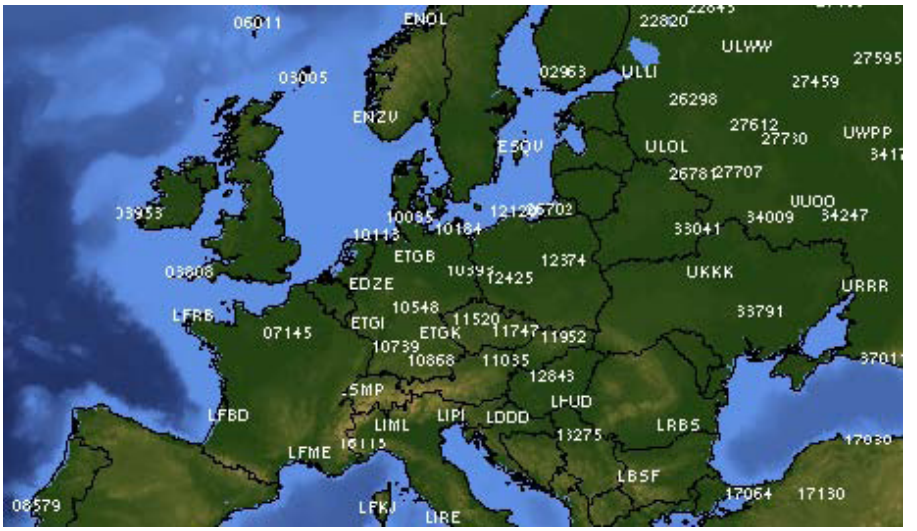
thanks to the Meteorological Office and water management of the system of 8 radars (POLRAD) (Fig. 3). They are located in various parts of the country. The Central Radar Operating Centre (CROO) is in Warsaw. All radars are automated, operated and steered remotely. Satellite information is sent directly to the CROO. Data from the radar network is used for the meteorological cover of aviation, sea transport, energy and water management, road transport, farming, tourism and for media news bulletins, and the like.

The aerological stations

At aerological stations (900 globally, 3 in Poland)[9] regular measurements consisting of tonographies, temperatures and humidities of the air are taken using automatic apparatus in balloons filled with hydrogen or helium; results are sent over the radio to the station equipped with the appropriate devices; in this way, information about the vertical profile of the atmosphere is obtained at an alt. of 30 km. In some aerological stations, the vertical profile of the content of ozone is also outlined. Aerological measurements in Polandare taken at: Łeba, Legionowo, and Wrocław. For everyone interested in obtaining information from radiosurvey measurements, I recommend the site of the University Wyoming - USA (fig. 4, 5). [http://weather.uwyo.edu/upperair/sounding.html][10].

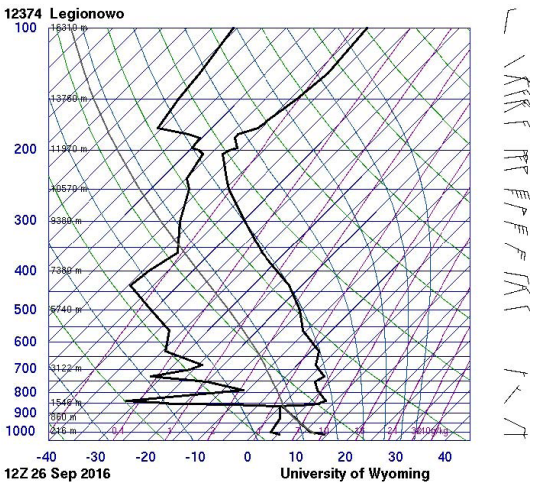
9 http://encyklopedia.pwn.pl/haslo/meteorologiczne-pomiary-i-obserwacje;3940082.html.

10 Department of Atmospheric Science University of Wyoming.



Source: http://weather.uwyo.edu/upperair/sounding.html.

Fig. 4. Map of aeorological stations (with international numbering system of the hydrometeorological information exchange) across Europe.



Source: http://weather.uwyo.edu/upperair/sounding.html.

Fig. 5. Example of an aerograph (temperature range T and Td)[11] from the station Legionowo (12374) near Warsaw

11 the **dew point** (**dew point temperature** or **dewpoint**) is the temperature at which a given concentration of water vapor in air will form dew. More specifically it is a measure of atmospheric moisture. It is the temperature to which air must be cooled at constant pressure and water content to reach saturation.

All available studies which graphical depicting survey data are on line, but copying them is banned. Therefore, from the position of a practitioner, I recommend the websites of American universities, traditionally, where there are no such impediments. They contain information and primary data from test points located worldwide, and also in Poland.

ISOK system (Computer System of the Cover of the Country from extraordinary threats)[12]

The concept assumes construction of the ISOK system and that the main data exchange between components of the system will take place via services in the SOA (Service Oriented Architecture). Fast adaptation to the changeable requirements will enable a system of users to be constructed. The architecture of the system puts the publication of spatial data on a map server within WMS (Web of Service Maps) and WFS (Feature Service Web) standards. Thanks to such a solution, the published data will be able to be easily acquired by any section of the architecture and interested users. Institutions responsible for town-and-country planning will be recipients of the results of the project and will plan for protection against flood. Above all, they will be the regional management boards of water management, responsible for the safeguard of areas threatened with flooding against developing them in a way that hampers protection. However, the overlords of communes and marshals of provinces are responsible for town-and-country planning. Taking project results into account is their duty (flood hazard maps and flood risk maps) regarding land use in communes and provinces. Als, responsible institutions will be recipients of ISOK products in accordance with the act regarding crisis management, behind the prevention for contingencies, preparing planned activities to be taken control of and reacting if they are withdrawn. In particular it is with regard to provincial centres of crisis management and other units of government and self-government administration, on the regional and local national level, dealing with protection issues before floods and other threats and critically reacting to them.

12 Look - [http://mapy.isok.gov.pl/imap/].

System SMOK (IMGW)[13]

SMOK - the System of the Monitoring and Cover of the Country - created after the tragic effects (economic, social and economic) of floods in 1997. Carried out for the Meteorological Office and the water management. It consists of a group of monitoring-measuring systems and data processing into the composition of the system:the location system of Atmospheric Discharges, the system of Meteorological Radars, the system of nearly 1000 automated stations put up in the entire country. It enables measuring data to be received - hydrological (states of rivers) as well as meteo data - (the fall, the temperature, the speed and the direction of the wind, humidity of air).

GEOPORTAL IMGW Aviation (the Meteorological Office and of Water Management)

Geoportal intended for pilots and aviation sympathizers, drawn up by IMGW (the Met. Office and Water Management). It contains meteorological and hydrological information drawn up based on data coming from network measurements - monitoring of the Institute. The information provided matches requirements included in the documents of the World Meteorological Organization (WMO) and, as part of the cover of aviation, in the regulations of the Organization of the international civil aviation (ICAO). 3 offices for meteorological forecasts function in the MOLC structure[14]:

The Central Office of Air Forecasts - MBN in Warsaw, the Central Office of Meteorological Forecasts in Cracow, the Office of Meteorological Forecasts in Wrocław. Thirteen Airport meteorological stations (in Bydgoszcz, Gdańsk, Katowice, Cracow, Łódź, Poznań, Rzeszów, Szczecin, Warsaw, Wrocław, Zielona Góra, Lublin and Modlin).

13 Look. [http://www.imgw.pl/index.php?option=com_content&view=category&id=49&Itemid=153].

14 MOLC - Meteorologiczna Osłona Lotnictwa Cywilnego (pol.). Look. [http://www.ulc.gov.pl/pl/].

GEOPORTAL IMGW Aviation (the Meteorological Office and of Water Management[15]

Geoportal intended for pilots and aviation sympathizers, drawn up by IMGW. It contains meteorological and hydrological information drawn up based on data coming from network measurements - monitoring of the Institute. The information provided matches requirements included in documents of the World GEOPORTAL ICM Organization (Interdisciplinary Centre of the Mathematical Modelling) at Warsaw University.

It is a provision of weather maps (analysis and the forecast), of mathematical numerical models drawn up on the base, and the depiction of the forecast of elements and phenomena of the weather for the chosen sites in Poland and in chosen states. Apart from the results of models drawn up in ICM (old and new), the service also provides 10-day global model GFS (The Global Forecast System) forecasts. The service also contains everyday comments of the weather forecaster ICM Information.

GEOPORTAL ICM (Interdisciplinary Centre of the Mathematical Modelling) at Warsaw University

It is the provision of weather maps (analysis and the forecast), of mathematical numerical models drawn up on the base and the depiction of the forecast of elements and phenomena of the weather for the chosen sites in Poland and in chosen states. Apart from the results of models drawn up in ICM (old and new), the service provides 10-day global model GFS (The Global Forecast System) forecasts[16].. The service also contains everyday comments of the weather forecaster ICM Information, which are available at: www.facebook.com / MeteoICM.

15 Look. [http://awiacja.imgw.pl/].

16 The Global Forecast System (GFS) is a weather forecast model produced by the National Centers for Environmental Prediction (NCEP). Dozens of atmospheric and land-soil variables are available through this dataset, from temperatures, winds, and precipitation to soil moisture and atmospheric ozone concentration.

Geoportal of being the boss of the Hydrometeorological Service of the military forces of the Republic of Poland[17]

Unfortunately, hydrometeorological information is accessible only after logging on to a portal if you know the password. Information concerning the history of being the boss of the Hydrometeorological Service is readily available, with the current weather in Poland (drawn up in an interesting design) and a set of military METAR telegrams.

The accumulation and the real-time processing of hydrometeorological data is main purpose of the military hydrometeorological service of the entire world in order to provide safe take-offs and landings of aircraft in the any area of the world; hydrometeorological data protects military forces in the countryThe SP meteorological service constitutes an integral part of meteorological-oceanographic services (METOC)[18] NATO.

Conclusions

Before the accession to the European Union, the need for creating integrated security systems, warnings about the appearance of dangerous phenomena and flood threats, was only realized after natural disasters - unfortunately decision-makers quickly forgot about the promises made, particularly becausehydrometeorological security policy necessitated considerable expense. The "flood of the millennium" in 1997 revealed all this negligence, and it extended over 30% of the country. Thus they decided to allocate bigger funds to create a first professional warning system, a "Dragon", a development of the system of warning radars (for the entire country area), and to increase the scope of investment in hydrotechnical infrastructure for flood banks, and for new bodies of water and reconstruction of destroyed areas. Our accession to the European Union in 2004 increased available financial means, especially for investments in the sphere of safety. Therefore, recent years have

17 Look. http://meteo.sp.mil.pl/.
18 METOC (Meteorological and Oceanographic Military Committee).

determined the creation of a Computer System of Cover of the Country - ISOK which is constantly modernised and enriched with new functions. This can be an indicator of progress, , an information system radar area covering the entire territory of Poland, partly modernised and supplemented with new devices.

Bibliography

Drzewiecki D., 2001 – Geneza i dynamika wybranych zjawisk pogody niebezpiecznych dla lotnictwa (na przykładzie zachodniej części dorzecza górnej Wisły), praca doktorska, Uniwersytet Śląski, Wydział Nauk o Ziemi, Sosnowiec

Burroughs W.J. 1991, Watching the world's weather. Cambridge University Press, Cambridge.

Drzewiecki D., Chaładyniak D., 2000, *Satellite images acquisition from the Internet for military meteorologists educating*. IV International Symposium on Military Meteorlogy, Hydro-meteorological support of allied forces and PfP member's tasks realization, Malbork Poland 26- 28 September 2000, materiały konferencyjne, s. 69- 76.

Chaładyniak D., Drzewiecki D., 2001, *Application of GIRD data and satellite images investigation of frontolysis process*. Uniwersytet Gdański, Rocznik fizyczno-geograficzny, tom VI 2001, Zastosowanie danych girdowych w klimatologii i hydrologii, s. 51-5

Drzewiecki D., 2003, *Winds frequency in the strong different form of the ground.* V International Symposium on Military Meteorology, Metoc Services' Tasks in NATO Operations, Missions and Exercises, Poznań Poland 1 – 3 October 2003, s. 67–69

Drzewiecki D., 2005, Problematyka przetwarzania danych klimatycznych. Zeszyty Naukowe Akademii Obrony Narodowej Nr 1(58)A, Warszawa 2005, s.185-194.

Drzewiecki D., 2015, Meteorological elements of selected historical events based on the weather map digital reconstruction, Security and Defence, Central European Forum on Military Education, National Defence Uniwersity (Akademia Obrony Narodowej), Quarterly No 4, Warszawa 2015, s. 49 – 57

German Advisory Council on Global Change (WBGU), 2007 – "Climate Change as a Security Risk", Berlin, Germany

Graniczny M., Mizerski W., 2009, Katastrofy przyrodnicze, Wydawnictwo Naukowe PWN, Warszawa

Heede Richard, 2013 – "Tracing anthropogenic carbon dioxide and methane emissions to fossil fuel and cement producers, 1854-2010", Climatic Change (2014), Article is published with open access at Springerlink.com

IPCC, 2014 – Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN) "Special Report of the Intergovernmental Panel on Climate Change", Cambridge University Press, UK and New York, NY, USA

Janiszewski F., 1988 - *Instrukcja dla stacji meteorologicznych*, Instytut Meteorologii i Gospodarki Wodnej, Wydawnictwa Geologiczne, Warszawa, s. 66 – 69

Jafernik H., Wilczek Z., Ziarko J., 2000, Meteorologiczna osłona działań lotnictwa. Dom wydawniczy Bellona, Warszawa

J. D. Macdougall, 2004 – "Frozen Earth: The Once and Future Story of Ice Ages" University of California Press, Ltd

Klucze FM 12 – XII Ext. SYNOP, DO SZYFROWANIA WYNIKÓW PRZYZIEMNYCH OBSERWACJI METEOROLOGICZNYCH, dla celów synoptycznych, oraz KLUCZE STORM – AVIO, Warszawa 1996

Moran J., Morgan M., 1989, Meteorology the atmosphere and the science of weather. MPC New York

Ostrowski M., 1999, Meteorologia dla lotnictwa sportowego. Aeroklub Polski. Warszawa

The CNA Corporation, 2007 – "National Security and the Threat of Climate Change", Alexandria, Virginia , USA

Wpływ zmian klimatu na środowisko, gospodarkę i społeczeństwo (zmiany, skutki i sposoby ich ograniczania, wnioski dla nauki, praktyki inżynierskiej i planowania gospodarczego), tom 3, Klęski żywiołowe a bezpieczeństwo wewnętrzne kraju, Instytut Meteorologii i Gospodarki Wodnej, 2012

Zagrożenia okresowe występujące w Polsce, Rządowe Centrum Bezpieczeństwa RCB – Warszawa, 2013