EVALUATION OF WMO RA VI. AGROMETEOROLOGICAL QUESTIONNAIRE RELATED TO PHENOLOGICAL OBSERVATIONS AND NETWORKS

VREDNOTENJE WMO RA VI. AGROMETEOROLOŠKE ANKETE – FENOLOŠKA OPAZOVANJA IN MREŽE

Attila Bussay[1]

POVZETEK

Na anketo WMO RA VI. se je odzvalo 28 držav ter mednarodni center (EU - Joint Research Centre). Omenjeno število držav predstavlja 57 % vseh članic RA VI. (Regional Association). Od 28 ima kar 22 (79 %) držav vzpostavljeno mrežo fenoloških opazovanj: Armenija, Avstrija, Češka republika, Estonija, Francija, Hrvaška, Irska, Italija, Latvija, Litva, Madžarska, Makedonija, Moldavija, Nemčija, Romunija, Rusija, Slovaška, Slovenija, Španija, Švica in EU (JRC). Mreža fenoloških opazovanj ni vzpostavljena v Belgiji, Bosni in Hercegovini, Danski, Luksemburgu, Portugalski ter Združenem kraljestvu. S fenološkimi opazovalnimi mrežami večinoma upravljajo državne meteorološke oziroma hidrometeorološke službe. Prve mreže fenoloških opazovanj datirajo v dvajseta leta tega stoletja, večina opazovalnih mrež pa je bila vzpostavljenih v štiridesetih in petdesetih letih. Nekaj je tudi mlajših. Gostota opazovalnih mrež se med državami močno razlikuje. V splošnem mreže fenoloških opazovalnih postaj zajemajo dve vrsti postaj: postaje, kjer se opazuje fenološke faze gojenih rastlin ter postaje, kjer se opazuje pretežno negojene rastline. Večinoma so fenološke postaje vezane na farme, sadovnjake ter klasične meteorološke postaje. Nekaj pa je tudi eksperimentalnih postaj. Približno 61 % opazovalcev na fenoloških postajah opravlja delo profesionalno. V treh četrtinah obravnavanih držav potekajo opazovanja celo leto. Opazovanja so v rastni dobi bolj pogosta, navadno vsake dva dni, ponekod pa je razmak med opazovanji tudi daljši. Izven rastne dobe so opazovanja tedenska do mesečna. Zbiranje podatkov pridobljenih z opazovanji je različno - od dnevnega do letnega. Najbolj pogosto gre za mesečni termin. Informacijo o varieteti (kultivarju) vključuje v svoje podatke 90 % držav. Najbolj pomembna in s tem tudi pogosta so opazovanja kmetijskih rastlin, sledijo jim gozdna drevesa in grmičevje, na tretjem mestu pa so sadna drevesa. Najmanjši pomen se pripisuje negojenim rastlinam. K opazovanim podatkom so pogosto dodane še specifične informacije povezane s kmetijskimi deli (npr. dodajanje hranil, čas žetve, gostota rastlin,...). Običajno (78 % obravnavanih držav) baze fenoloških podatkov vsebujejo tudi informacijo o pridelku ter ekstremnih dogodkih (76 %). Večina držav ima fenološke podatke, opazovane od

[1] Hungarian Meteorological Service, Climatological and Agrometeorological Division, Budapest, P.O. Box 38, 1525 Budapest, Hungary, bussay@met.hu

leta 1980 dalje, shranjene na elektronskem mediju, 4 izmed obravnavanih držav pa imajo v elektronski obliki celotno bazo fenoloških podatkov. Sam način zapisa podatkov (kodiranje) pa se med državami močno razlikuje. Fenološki podatki se najbolj pogosto uporabljajo kot informacija (agrometeorološka poročila), sledi jim uporaba v raziskavah ter vrednotenje agroklimatskih razmer. Pomembno vlogo pa igrajo tudi pri modeliranju pridelka. Glavni uporabniki so tako raziskovalci ter kmetijski svetovalci. V splošnem lahko ugotovimo, da se metode opazovanja, strukture opazovalnih mrež, način zapisovanja ter uporaba podatkov med posameznimi državami močno razlikujejo. Zato je namen WMO RA VI. Regional Association vzpodbuditi in podpirati standardizacijo opazovanj ter formata zapisa fenoloških podatkov. Pomembno je tudi poiskati povezave med fenološkimi in meteorološkimi podatki ter s tem povečati praktično uporabnost fenoloških podatkov npr. z uporabo pri modeliranju pridelka ali pri mikroklimatski klasifikaciji.

Ključne besede: fenologija, baze podatkov, mreža fenoloških opazovanj

Our questionnaire resulted in replies from 28 countries and from one international centre (Joint Research Centre). The answers seems to represent the given region properly but unfortunately we got only limited information (one completed questionnaire) from the Scandinavian countries. The 28 replying countries mean 57% of the members RA VI. Regional Association. The replies were positive namely regular phenological observations or networks exist in the following 22 countries: Armenia, Austria, Croatia, Czech Republic, Estonia, France, Germany, Hungary, Ireland, Italy, Izrael, Latvia, Lithuania, Macedonia, Moldova, Romania, Russia, Slovakia, Slovenia, Spain, Swiss, Syrian Arabic Republic and in the EU (JRC). We received negative answers from the next 6 countries: Belgium, Bosnia and Hercegovina (it existed from 1951 to 1992 but due to the civil war, the phenological observations were ceased, recently the old data are used), Denmark, Luxembourg, Portugal (there are phenological observations although without an organised network) and United Kingdom. It means that there are phenological observations in the 79 % of the states, which ratio is favourable.

This ratio would probably be even higher, if one took into consideration other phenological networks like International Phenological Gardens (IPG), plant improvement companies, cultivar experiment agencies, geographical societies, universities, plant protection services, forestry maintainers etc. The phenological networks are maintained by national meteorological or hydrometeorological services in 18 countries, only 5 countries place was reported other owners. The 2 oldest networks were organised in the 1920's and the most main time new phenological networks were initiated in the 1940's and 1950's (6 and 6 country, respectively). There are some relatively new observation systems starting in the 1980's (3 country) (Figure 1).

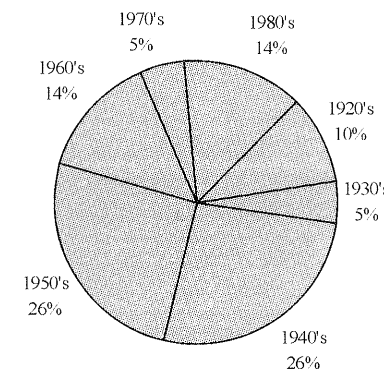

Figure 1: Date of establishment of phenological networks.

The density of networks shows great variability. The most dense phenological network works in Italy and in JRC (EU) (approximately 1 phenological station/ 100 km2) and the most sporadic is in France (approximately 1 station /100000 km2). The mean value of network density is 1 observation / 7400 km2. There exists no clear connection between the network density and the area of countries or the number of phenological stations.

The main part of networks are classified (74%) and there are not classified only in 6 cases (26 %). In spite of this fact, it seems that the phenological networks are not homogeneous considering the reported states. There are two main types of phenological networks: 1., agrometeorological, where mainly cultivated plants are observed and 2., (agro)climatological, where wild plants have emphasised importance. The distribution of phenological stations in given categories are showed on Figure 2.

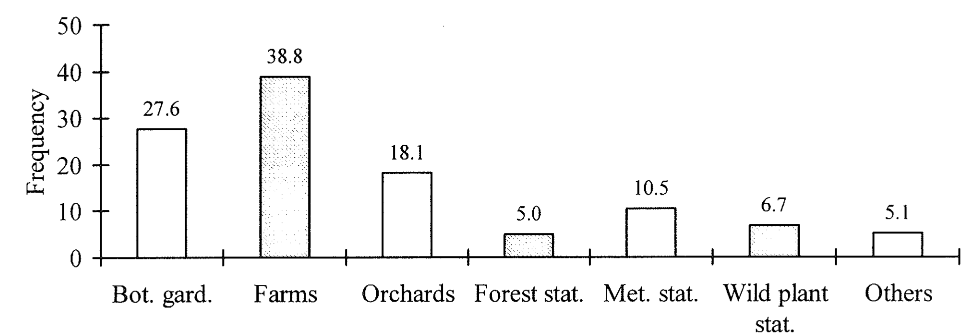

Figure 2: The frequency of phenological station types.

Most of observations are located at productive farms (39%) and orchards (18%) but also experimental stations (24 %) occur frequently. In two countries (Lithuania and Estonia) the phenological observations are connected to the normal meteorological measurements and stations. Other categories like forest and wild plant observing station, botanical garden, town and other places occur only infrequently albeit.

The qualification of observers is an undoubtedly important question, while it is one prominent component of data quality. In 21 countries, the observers are partly or fully professionals (specially qualified people), like agrometeorologists, agronomists, foresters etc. The ratio of professional observers is averaged at 61 %, which is considered high. This ratio changes large magnitude from the practically fully voluntary observers (0-1% professional observer) to fully professional (100 %) systems.

In three quarters of the countries observations are conducted during the whole year not only during the season. Naturally, observations are more frequent in the growing season. During the growing season, phenological observations are made in every one or 2 days (most commonly), but there exist some countries, where the frequency is 5 days, weekly or 10 days. Generally observations in orchards are less or equally frequent than concerning agricultural plants. Out of the season observations are made following frequency: only on a weekly, 10 daily or monthly basis.

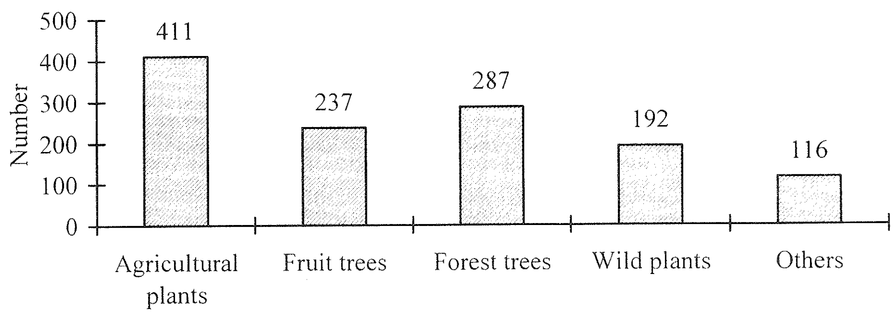

Figure 3: Number of observed species.

Frequency of data collection varies from daily to annually. The most common is the monthly data collection (Figure 3), but practically several (1, 2 or 3) parallel systems can exist simultaneously in one country. Sometimes these systems differ in the channels of data transmission. For annual data collection ordinary mail are appropriate in contrast to for quick (immediate) reporting stations, where the telephone, fax or similar methods are the most common. The data collecting channels are mostly via mail and telephone, but could also be telex, fax, telegraph or computer lines (intranet). The varieties (cultivar) information are incorporated into the data in 90 % of the total and left out only 10 % of the countries. The phenology of agricultural and vegetable plants has the greatest importance, the second highest value is the class of forest trees and bushes, the third one is the fruit trees and bushes, while wild plants have the lower

importance. In few cases there are special phenological observations, like insect (bee), bird, plant diseases (Figure 3).

In order to increase the applicability and relevance extra information is also collected in 64 % of the countries. This include notes on agricultural practices, like nutrient supply, plant protection, time of sowing, plant density etc. Yield data are incorporated into the data sets in 78% of the countries, but it seems to be not relevant in the case of wild plants (less than 25%). Some information about the natural disasters are used in the 76 % of the phenological data banks.

In the last 30-40 years, the observation methods needed to be modified to adapt to changes in the structure of national meteorological services, development of social and technical environment of phenological observations. In two thirds of meteorological services, the phenological network has been altered since 1961. This number approximately equals to the number of existing networks in 1961, which means essentially that the all 'old' networks were more or less reorganised. In the last few years one third of the networks or methods were modified, but it seems that these changes have limited impact and in 75% of cases the results of the new observations remained comparable to the old ones. All countries keep their data on paper, resulting from the early start of phenological observations. In the last few years the use of computers become prevalent (75%). Most of countries have the phenological data on computers since 1980, but 4 countries have all the phenological data on computers as well.

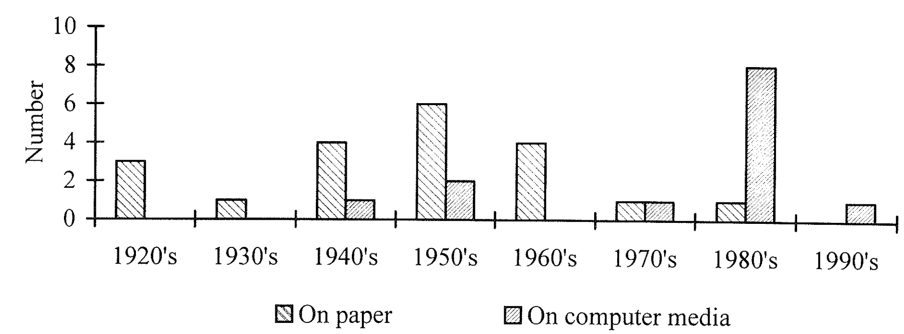

Figure 4: Data storage format.

The use of phenological coding is not common, only two thirds of the countries use any code. 10 countries reported the use of local (national specific) codes. Decimal scale is applied only in 6 countries therefore it cannot be considered common system. Other standard codes are used in 4 countries. The volume of stored data is the function of the number of observation places, observed plants, length of time series and the computer format of data storage. The smallest value (simple text format) is 1 MB, but in the case of extended networks and special data formats (Microsoft Excel, relational data base administrative programs) it could exceed 100 MB. The highest value (400 MB) is reported from Italy.

It is very important to identify the usage of phenological data (Figure 5). The main usage (37%) concerns agrometeorological reports, bulletins. The second greatest usage is research (24 %) and agroclimatic evaluation (22 %). It is not possible to neglect the importance of crop modelling (14 %), since the phenological development is one of the core parts of the crop-weather models. This fact also determines the distribution of data customers. The main users of phenological data are researchers (37 %) and farming advisors (30 %), but it is also used in a great extent in yield forecasting and yield estimation (18 %). Data are also used in other fields like environmental agencies (8 %), insurance companies (1 %), media (5 %), universities and education (2%) and allergology (0.5%).

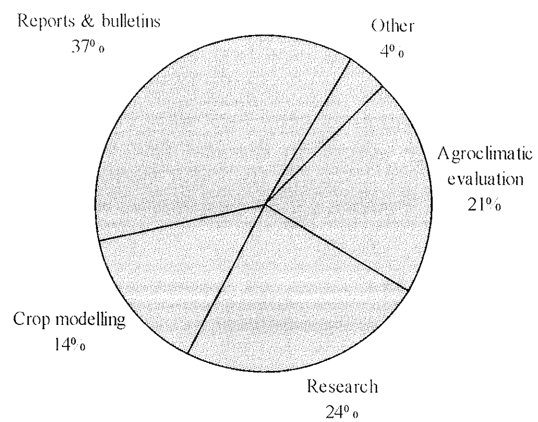

Figure 5: Type of usage of the phenological data.

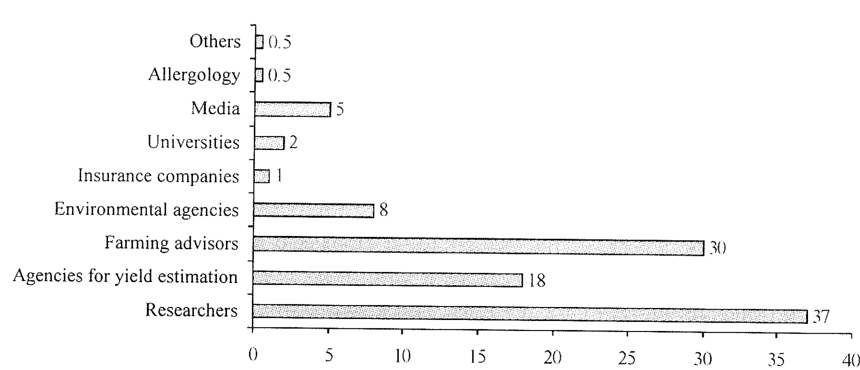

Figure 6: Distribution of users of phenological data.

In order to disseminate the data in operative use several media are applied (Figure 6). These include telephone (16%), bulletin, digital form (computer lines, internet, intranet, magnetic disk) and mailing (12 % respectively) and newspapers (10 %). Other possibilities are smaller, there are radio (8%), telex, fax, teletext (6%), television, telegraph, regional agrometeorological centres (4%).

GENERAL REMARKS AND RECOMMENDATIONS

Surprisingly high number of answers were received to our questionnaire. The great ratio of existing observations and networks shows the importance of the phenology. The main reason of this can be the connection between natural environment (agronomic practice, agricultural research, wild plant developing stage) and the agrometeorological or agroclimatological practice or research.

However, the several existing problems cannot be denied either. The observed plant or rarely animal species and the observed phenological phases change from country to country. The accuracy of the observed phenological phases and data varies in a wide rage. One of the main factor acting on the data quality is the skill of the observers and the handbook of they use. The data quality depend not only on the qualification of observers, but also on the observed phenological phases, e.g. it is easier to observe the first flower than the 50 % flowering. Some conference or expert meeting or handbooks could increase the accuracy reliability and comparability of measurements.

There is a lack of international co-operation, although some exception exist, e.g. the IPG and the Central European Initiative in Phenology. The phenological observations, the applied observation methods, the structure of networks, the coding systems and the practical usage of data are highly diverse. The WMO RA VI. Regional Association can take the initiative and assist the countries of the region to standardise observations and phenological data format at least in some extent. It is also imperative to find the connections between meteorological variables and different phenological stages, to increase the practical usage of phenological data, by giving examples from yield forecasting to the microclimatological classification. Organization and maintenance of phenological networks often raise special problems, sometimes it is similar to the normal meteorological networks. It would be useful to collect some experiences on this field.