საქართველოს სსრ მეცნიერებათა აკადემიის მოამბე, 172, #2, 2005
BULLETIN OF THE GEORGIAN ACADEMY OF SCIENCES, 172 #2, 2005

HYDROLOGY

V. Tsomaia, T.Tsintsadze, L.Kaldani

**FUTURE OF PALEOHYDROLOGY IN THE CAUCASSYS**

Presented by Member of the Academy Ts.Mirtskhulava, Jyne 25, 2005

**ABSTRACT. Based on measured precipitation and air temperature data as the basic parameters of heat and moisture the new approaches for the defibition of basic parameters of moisture axchange cycle in the atmosphere are offered. ©2005 Bull. Geirgia Acad. Sci.**

**Key words: paleohology**

Little is known about paleophydrology so, but it is very important to deal with the consecutive findings and generalization of changes of hydrological conditions dyring geological and hudtorical epoch.

The air temperature ($t^0$,C) and atmospheric precipitation ()P,mm) serve as the basis of an assessment for change ofheat and moisture ratio (Tabl 1( [1]. In this information precipitation includes abvective ($P_a$) and convective ($P_k$) ones [2].

$$P= P_a + P_k \qquad (1)$$

From the annalysis of the materials conecerning Cavcasus [3] it is stated that ($P_a$) and ($P_k$) equal to:

$$P_a=(P+h)0.5 \text{ and } P_k-=(P-h)0.5. \qquad (2)$$

Fig.1 shows the depedence of $P_a$ from P for all 500 – meter high-altitude zones of the

Table 1

Average annual air temperatures ($t^0$C) ahd atmospheric procipitation (P, mm) [1]

| Geological epoch and periods | $t^0$C | P, mm | Calculations under formulae | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Formulae | $P_a$, mm | h mm | E, mm | Coefficients of | |
| | | | | | | | moisure rotion | dain |
| Archaean | 33 | 1750 | (4) | 1414 | 1077 | 673 | 1.24 | 0.62 |
| Proterizoic | 15 | 1000 | (4) | 714 | 428 | 577 | 1.40 | 0.58 |
| **Palaeozoic**<br>Cambrian | 14 | 600 | (4) | 398 | 196 | 404 | 1.51 | 0.39 |
| Ordovician | 12 | 400 | (3) | 218 | 35 | 364 | 1.83 | 0.09 |
| **-Silurian**<br>Devonian | 14 | 300 | (3) | 162 | 24 | 276 | 1.85 | 0.08 |
| Coal | 10 | 600 | (4) | 398 | 196 | 404 | 1.51 | 0.33 |
| Permian | 8 | 400 | (5) | 267 | 134 | 266 | 1.50 | 0.34 |
| **mesozoic**<br>Triassic | 12 | 600 | (4) | 398 | 196 | 404 | 1.51 | 0.33 |
| Jurassic | 4 | 600 | (7) | 460 | 319 | 280 | 1.30 | 0.53 |
| Cretaceous | 10 | 600 | (4) | 398 | 196 | 404 | 1.51 | 0.33 |
| **Caenozoic**<br>Eocene | 3 | 400 | (7) | 362 | 203 | 196 | 1.32 | 0.51 |
| Miocene | 10 | 600 | (4) | 398 | 196 | 404 | 1.51 | 0.34 |
| Pliocene | 3 | 400 | (7) | 362 | 203 | 196 | 1.32 | 0.51 |
| Holocene | 5 | 500 | (6) | 354 | 208 | 202 | 1.41 | 0.42 |

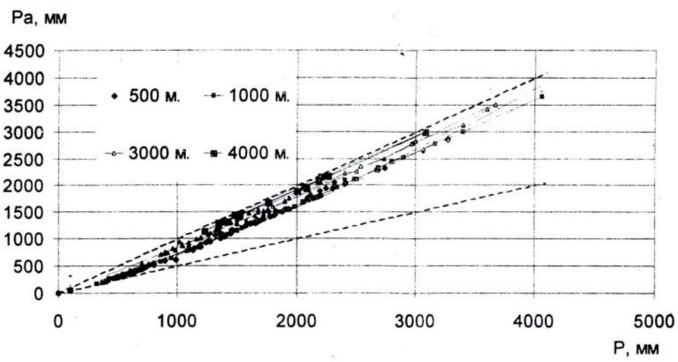


Fig. 1. Dependence of advective precitation ($P_a$) from the general precipitation (P) for highaltituds zones: above 4000 m, 3000 m (cptve 3 and 1000 m (corve 4) for Cavcasus.

Cavcasus

With regard to air temperature the design formulae (Table. 2) in which in the presence of { it is possible to define $P_a$ and h under formulae (1 and 2) have been received for the first time. The results of calculations fully coordinate with factual ones, the average mistake makes 1.5-3.0 % [2]. That is confirmed by the result of drain calculation for 13 meteorological stations of Colhis lovland (Table 3). The numbers of cases having a mistake of 5-6% is 1.3 times below accuracy of definition from a curve of water flow and makes 91%, and the average mistake is 3.3%.

Table 2

Formulae for calculations $P_a$

| Areas (high-altitude zones) where: | | | Formulae | Verification of approximation | # of formulae |
|---|---|---|---|---|---|
| (H), m | (P), mm | (t) $^0$C | | | |
| >500 | <500 | 9.0+14.5 | $P_a=P(1.00x10^{-5}P+0.540)$ | 0.8949 | (3) |
| | >500 | 9.0+14.5 | $P_a=P(1.25x10^{-5}P+0.589)$ | 0.9999 | (4) |
| 500-1000 | | 10.3+7.8 | $P_a=P(8.00x10^{-5}P+0.635)$ | 0.9962 | (5) |
| 1000-1500 | | 7.8+5.0 | $P_a=P(7.00x10^{-5}P+0.680)$ | 0.9965 | (6) |
| 1500-2000 | | 5.0+2.0 | $P_a=P(6.00x10^{-5}P+0.730)$ | 0.9971 | (7) |
| 2000-2500 | | 2.0+0.8 | $P_a=P(5.00x10^{-5}P+0.765)$ | 0.9945 | (8) |
| 2500-3000 | | -0.8+3.3 | $P_a=P(4.00x10^{-5}P+0.800)$ | 0.9958 | (9) |
| 3000-3500 | | -3.3+-6.2 | $P_a=P(3.00x10^{-5}P+0.870)$ | 0.9971 | (10) |
| 3500-4000 | | -6.2+-10.0 | $P_a=P(1.00x10^{-5}P+0.937)$ | 0.9975 | (11) |
| >4000 | | <10.0 | $P_a=P(1.00x10^{-5}P+0.960)$ | 0.9981 | (12) |
| Afrika | | >20+25 | $P_a=P(7.90x10^{-5}P+0.540)$ | 0.9930 | (13) |
| Australia | | >20+25 | $P_a=P(8.90x10^{-5}P+0.594)$ | 0.9980 | (14) |

The offered sheme allows assessing other parameters of moisture rotalion by thw example of coefficient of moidture rotation (k) showing the „number of cycles, made by local steam before it is taken beyond the biunds of formilory“ [2].

$$k=P/P_a=1+(El/2wu). \qquad (15)$$

For calculatiom the moisture of atmosphere in mm is requrired, the average speed of sffective transportion of water station (w) in m/s; scale of territory ($l=\sqrt{A}$,wherein A is the area of region – km$^2$. In view of absence of these date, new formula is affered, which contains characteristics provided in Tabel 1.

Table 3

Results of calculation of elements of moisture rotation in an atmospere at meteorological stations of Colchis lowland

| Meteorological station | (H), m | Basic data | | | Calculated drain under formula (9) | |
|---|---|---|---|---|---|---|
| | | (P), mm | (t) $^0$C | Drain mm | mm | Difference % |
| Sukhumi | 116 | 1366 | 14.5 | 815 | 710 | 12.9 |
| Gali | 63 | 1569 | 13.7 | 894 | 895 | -0.1 |
| Anaklia | 3 | 1458 | 14 | 842 | 791 | 6.1 |
| Zugdidi | 117 | 1616 | 13.8 | 940 | 941 | -0.1 |
| Mukhuri | 260 | 2097 | 13.8 | 1430 | 1473 | -3 |
| Tsalenjikha | 222 | 1825 | 13.3 | 1221 | 1158 | 5.2 |
| Akhuti | 172 | 1719 | 14.1 | 1002 | 1045 | -4.3 |
| Senaki | 40 | 1669 | 14.5 | 1020 | **3 | 2.6 |
| Poti | 1 | 1768 | 14.1 | 1235 | 1096 | 11.3 |
| Samtredia | 25 | 1375 | 14.4 | 749 | 717 | 4.3 |
| Lanchkhuti | 20 | 1824 | 13.8 | 1206 | 1156 | 4.1 |
| Supsa | 7 | 2192 | 13.5 | 1596 | 1591 | 0.3 |
| Kobuleti | 1 | 2320 | 13.9 | 1774 | 1759 | 0.8 |

$$K=P/P_a=2P/(P+h). \qquad (16)$$

Checking of the foemula (16) for all Europe (predipitation 7540 km$^3$, drain 3080 km$^3$) k=1.42 (actual 1.42), for South America (precipitation 28400 km$^3$, drain 5400 km$^3$) k=1.68 (actual 1.68), etc. By the recommended formulae in a basin, region, continent of any configuration the parameters of moisture rotacion of various geological epochs (columens 4-9 of Table 1.) have been calculated that give a astisfactory result.

Comparisons of date by the climatic comdicions of the earlier and contemporary periods (Table 4 [1]), showed that for Eocean and Pliocene under average air temperature 3$^0$C amd precipitation 400 mm, advective precipitation 302 mm, drain – 204 mm, and coefficient of drain 0.51 have been received Similar climatic conditions are available in a high-altitude zone of 1500-2000 m in the Caucasus within the basins of the ruvers Archichi, Gavaret, Nakhichevanchai, Vilijachi and Lenkoran. in spite of rather lavish precipitation (500-580mm), the corfficient of drain appeard within the limits of 0.41-0.53, close to the value of coefficient of drain in Eobene and Miocene. The same turns out for thr Cambrain and the Devonian periods under air temproture of 14$^0$C and precipitatipn of 300-600mm. Similar temperature conditions are availale in a high-altitude zone below 500m in te basins of thr rivers Bol. Laba, Kuban and Bol. Liakvi. Here the corfficient of drain – 0.15-0.23 is haigher than in Cambrian and Devonian periods that corresponds to actual conditions and enables considering the results of calculation of moisture rotation permanents for the historical periods as positive ones.

Table 4

Results of comparison of early and contemporary compatible data by climatic conditions

| Period | Rivers | t, ($^0$C) | P, (mm) | formula | $P_a$ mm | h, mm | Coefficent of drain h/x |
|---|---|---|---|---|---|---|---|
| Eociane Pliocene | | 3 | 400 | (7) | 302 | 204 | 0.51 |
| | | 3 | 400 | (7) | 302 | 204 | 0.51 |
| | Archichi | | 540 | (7) | 380 | 220 | 0.41 |
| | Gavaret | | 580 | (7) | 380 | 220 | 0.44 |
| | Nakhchevanchai | | 530 | (7) | 404 | 278 | 0.52 |
| | Viljachai | | 560 | (7) | 428 | 296 | 0.53 |
| | Lenkoran | | 540 | (7) | 380 | 220 | 0.41 |
| Palaeozoic Cembrian Devonian | | | 600 | (3) | 328 | 56 | 0.092 |
| | | | 300 | (4) | 161 | 22 | 0.073 |
| | Bol.Laba<500 m | | 14 | (4) | 340 | 90 | 0.15 |
| | Kuban <500 m | | 14 | (4) | 358 | 96 | 0.10 |
| | Bol. Liakhvi<500 m | | 14 | (4) | 332 | 84 | 0.15 |

According to table 1 low-moistened conditions were typical for the Paelozoic epoh and the separate periods of Mesozoic (Triassic and Cretaceous) and Caenozoic (Miocene) epochs, ehren the drain was the lowest (24-134mm), corresponding coeffisients of drain were small too (within the limits of 0.08-0.15). In the others relatively humidifed periods at change of precipitation within the limits of 600-1750mm the drain chamged within the limits of 200-750mm, and the coefficient of drain was rather great (0.40-0.55). in general with reduction of moisture the drain and its coefficient decreases.

Full conformity of the cbtained results of interpretation according to air tempriture and atmospheric precipitation for a geological and historical epoch testifies, firts of all, the reliability of all design data and an opportunity of using the proposed scheme of an assessment of hydrologicak charasteristics against the background of expected climatic changes of our planet.

Georgian Academy of Sciences
Institute of Hydrometeorology

REFERENCES

1. K.S.Kalesnik. General Geographic Earth Regulary. Tbilisi, 1977,347 (Georgian).
2. Global Water Balans and Water Resources of the Earth. Editor, VI Korzoun. L. 1974, 638 (Russian).
3. L.A.Vladimirov, G.N.Gigineishvili, A.L.Javakhishvili, N.N. Zakarashvili. Water Balans of the Cavcasus and Geographic Regularities. Tbilisi, 1991, 141 (Georgia)

**ჰიდროლოგია**

**ვ. ცომაია, თ. ცინცაძე, ლ. ქალდანი**

**პალეოჰიდროლოგიის პერსპექტივები კავკასიაში**

**რეზიუმე:** შემოთავაზებულია ატმოსფეროში ტენბრუნვის ძირითადი პარამეტრების განსაზღვრა ახალი მიდგომით, რომელიც დამყარებულია ნალექებისა და ჰაერის ტემპერატურის გაზომილ მონაცემებზე, როგორც სითბოს და სინოტივის ძირითადი მაჩვენებელი.

ფორმულებით მიღებული შედეგები სრულად აღწერენ ნებისმიერი კონფიგურაციისა და ტერიტორიის გეოლოგიური (ისტორიული) პერიოდის მნიშვნელობებს.