

Comparative analysis of air equivalent - effective temperature in some cities of Georgia and Brazil

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1. INTRODUCTION

The bioclimatic properties of locality, and especially health resort-tourist zones, are frequently characterized by so-called equivalent-effective temperature of air (EET). EET is the combination simultaneously observed air temperature, relative humidity and wind speed, expressed by the conditional value of temperature, which creates the same sensation of heat as stagnant air at a relative humidity 100% and a specific temperature [Sheleikhovski, 1948; Rusanov,1981; Svanidze and Papinashvili, 1992; Saakashvili et al., 2010].

There are two scales of EET. A basic scale it corresponds to the heat-sensation of the exposed person, who is located in the shadow and who assumes air baths. Standard dial of EET corresponds to the heat-sensation of the dressed on the season person, who accomplishes small jaunts. In the correspondence with the standard dial are separated six basic gradations of EET (Table 1) [Rusanov,1981; Svanidze and Papinashvili, 1992; Amiranashvili, Danelia et al., 2010].

Table 1. The air Equivalent-Effective Temperature Scale (EET)

Temperature Range	(EET)
<1 °	Sharply coldly
1-8 °	Coldly
9-16 °	Moderately coldly
17-22 °	Comfortably
23-27 °	Warmly
>27 °	Hotly

Because of the development in Georgia of health resort- tourist industry the study of EET special attention began to be given. For example, the detailed statistical analysis of variations of air equivalent-effective temperature in Tbilisi and Kutaisi in the period from 1957 through 2006 is carried out [Amiranashvili, Kartvelishvili, 2008; Amiranashvili, Kartvelishvili et al., 2010]. In the work [Amiranashvili, Danelia et al., 2010] the results of the comparative analysis of the data about air equivalent-effective temperature and mortality of the population of Tbilisi city from the cardiovascular diseases are represented. It is shown that the existing scale of air equivalent-effective temperature can be applicable for the evaluation of the degree of its action on the health of people in Tbilisi city.

It is important to also draw a comparison of EET in Georgia with the values of this bioclimatic index in other countries. In this work the comparative analysis of mean monthly values of EET for 7 cities of Georgia and Brazil (state Alagoas) is carried out.

2. METHOD AND DATA DESCRIPTION

In the work the data of the weather service of Georgia and Brazil about the monthly average values of the air temperature, relative humidity and wind speed are used. Values of EET were calculated according to the formula, represented in [Sheleikhovski, 1948; Rusanov,1981]. Designations are given below: EET – the

air Equivalent-Effective Temperature, EET Corr - the air Equivalent-Effective Temperature (wind speed = 0, the places, protected from the wind).

3. RESULTS

The results in table 2 and fig. 1-4 are given.

Table 2. The air Equivalent-Effective Temperature in some location of Georgia and Brazil

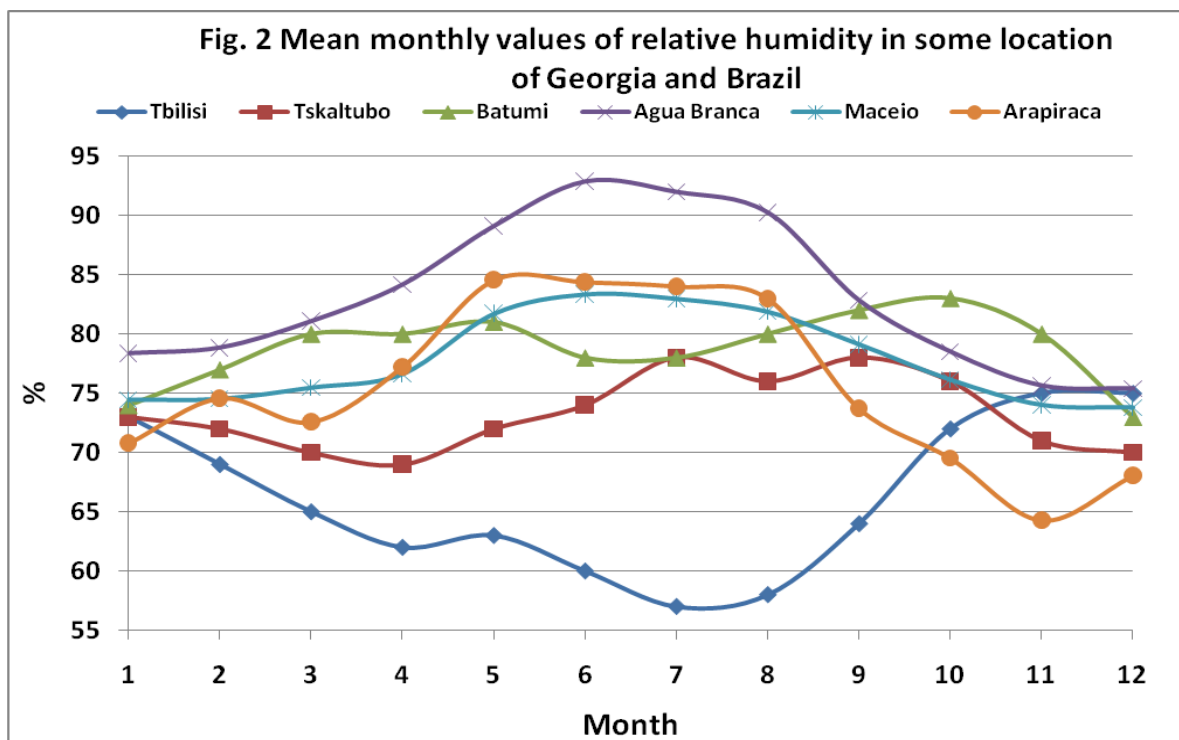
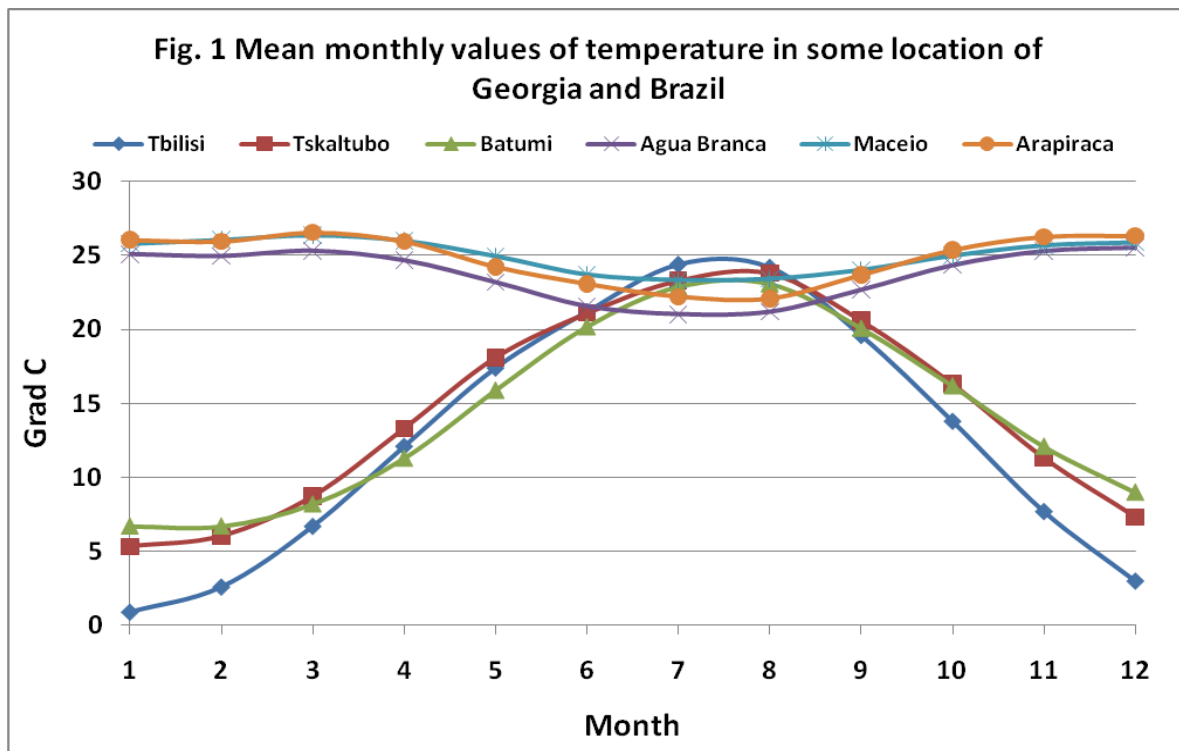
Georgia														
	Tbilisi		Tskaltubo		Anaklia		Batumi		Telavi		Gudauri		Bakuriani	
φ	41.72 N		42.33 N		42.4 N		41.65 N		41.93 N		42.47 N		41.73 N	
λ	44.8 E		42.62 E		41.57 E		41.63 E		45.48 E		44.48 E		43.52 E	
H(m)	403		121		3		2		542		2194		1665	
Month	EET	EET Corr	EET	EETC orr	EET	EET Corr	EET	EET Corr	EET	EETC orr	EET	EET Corr	EET	EET Corr
1	-10.1	0.5	-2.0	5.3	-4.4	5.4	-1.6	6.7	-11.3	0.1	-25.0	-10.3	-27.9	-9.9
2	-7.9	2.5	-0.9	6.0	-3.1	6.2	-1.8	6.7	-10.1	1.7	-25.9	-10.5	-26.6	-8.9
3	-1.3	6.8	2.3	8.7	0.6	8.7	1.4	8.3	-4.0	5.8	-18.4	-6.5	-17.0	-3.5
4	5.7	11.8	7.8	13.0	5.7	11.8	6.0	11.4	3.9	11.0	-9.1	-0.1	-6.6	3.5
5	12.4	16.3	14.2	17.3	12.3	16.2	12.1	15.7	10.9	15.4	-1.2	5.5	2.2	8.9
6	16.4	19.2	17.7	19.8	17.0	19.5	16.9	19.3	14.9	18.3	4.2	9.2	6.6	12.0
7	19.4	21.4	20.2	21.8	19.9	21.8	19.7	21.5	18.3	20.6	8.2	12.2	10.1	14.6
8	19.4	21.3	20.5	22.1	20.1	22.0	20.0	21.7	18.3	20.5	8.2	12.2	10.2	14.7
9	15.2	18.1	17.6	19.6	16.5	19.1	17.0	19.4	14.0	17.4	3.2	8.4	5.4	10.7
10	9.0	13.5	12.9	15.9	11.1	15.2	12.5	16.0	7.4	12.9	-3.2	3.9	-0.4	5.9
11	1.5	7.8	5.9	11.2	4.7	11.4	7.1	12.1	-0.4	7.0	-11.0	-1.9	-9.6	0.2
12	-5.8	2.8	0.9	7.4	-1.0	7.3	2.7	9.0	-7.4	2.3	-18.0	-6.7	-20.0	-6.3
Brazil														
	Agua Branca		Porto de Pedras		Maceio		Palmeira dos Indios		Pao de Acucar		Arapiraca		Coruripe	
φ	9.28 S		9.3 S		9.67 S		9.45 S		9.75 S		9.80 S		10.2 S	
λ	37.9 W		35.72 W		35.7 W		36.7 W		37.43 W		36.61W		36.47 W	
H(m)	605		50		64.5		275		19		241		74	
1	20.8	23.2	23.1	24.9	21.6	23.5	22.3	23.9	24.6	25.3	21.7	23.5	21.7	23.5
2	20.8	23.1	23.2	25.0	22.0	23.7	22.6	24.1	25.0	25.7	21.9	23.6	21.9	23.6
3	21.4	23.5	23.1	24.8	22.5	24.0	22.7	24.1	25.0	25.7	22.4	23.9	22.4	23.9
4	20.9	23.2	23.0	24.8	22.2	23.8	22.3	23.8	24.7	25.4	22.3	23.8	22.3	23.8
5	19.6	22.3	22.3	24.4	21.6	23.3	21.4	23.1	23.7	24.7	21.1	22.9	21.1	22.9
6	17.8	21.1	20.8	23.6	20.5	22.4	20.0	22.1	22.2	23.5	19.8	21.9	19.8	21.9
7	17.1	20.6	20.2	23.0	20.0	22.1	19.2	21.5	21.4	23.0	18.8	21.2	18.8	21.2
8	17.0	20.7	20.0	22.9	19.9	22.1	19.1	21.5	21.4	23.0	18.5	21.1	18.5	21.1
9	18.2	21.5	20.8	23.4	20.2	22.4	19.7	22.0	22.0	23.5	19.3	21.8	19.3	21.8
10	19.8	22.6	21.7	24.1	20.9	23.0	20.9	23.0	23.3	24.4	20.9	22.9	20.9	22.9
11	20.7	23.2	22.2	24.3	21.4	23.4	21.8	23.6	24.2	25.0	21.3	23.2	21.3	23.2
12	21.0	23.3	22.8	24.7	21.6	23.5	22.3	23.9	24.8	25.5	21.7	23.5	21.7	23.5

As it follows from table 2 for 7 stations of Georgia values of EET change from -27.9° (Bakuriani) to 20.5° (Tskaltubo), and values of EET corr – from -10.5° (Gudauri) to 22.1° (Tskaltubo). Or from “Sharply coldly” to “Comfortably”. For 7 stations of Brazil (state Alagoas) values of EET change from 17.0° (Agua Branca) to 25.0° (Pao de Acucar) , and values of EET corr – from 20.6° (Agua Branca) to 25.7° (Pao de Acucar). Or from “Comfortably” to “Warmly”. The Range (Max-Min) of EET for 7 stations of Georgia change from 38.1° (Bakuriani) to 21.8° (Batumi), and for 7 stations of Brazil – from 2.5° (Maceio) to 4.4° (Agua Branca).

The coefficient of variation of EET for 7 stations of Georgia change from 242% (Telavi) to 86% (Tskaltubo), and EET corr - from 665% (Gudauri) to 40% (Batumi). The coefficient of variation of EET for

7 stations of Brazil change from 4.2% (Maceio) to 8.3% (Agua Branca), and EET corr - from 3.0% (Maceio) to 4.9% (Agua Branca).

Thus, the essential difference in the contrast of space and temporary values of EET in these countries is noted. In Georgia the mean monthly values of EET cover range from “Sharply coldly” to “Comfortably”, and in Brazil (state Alagoas) values of EET during year change insignificantly from “Comfortably” to “Warmly”.



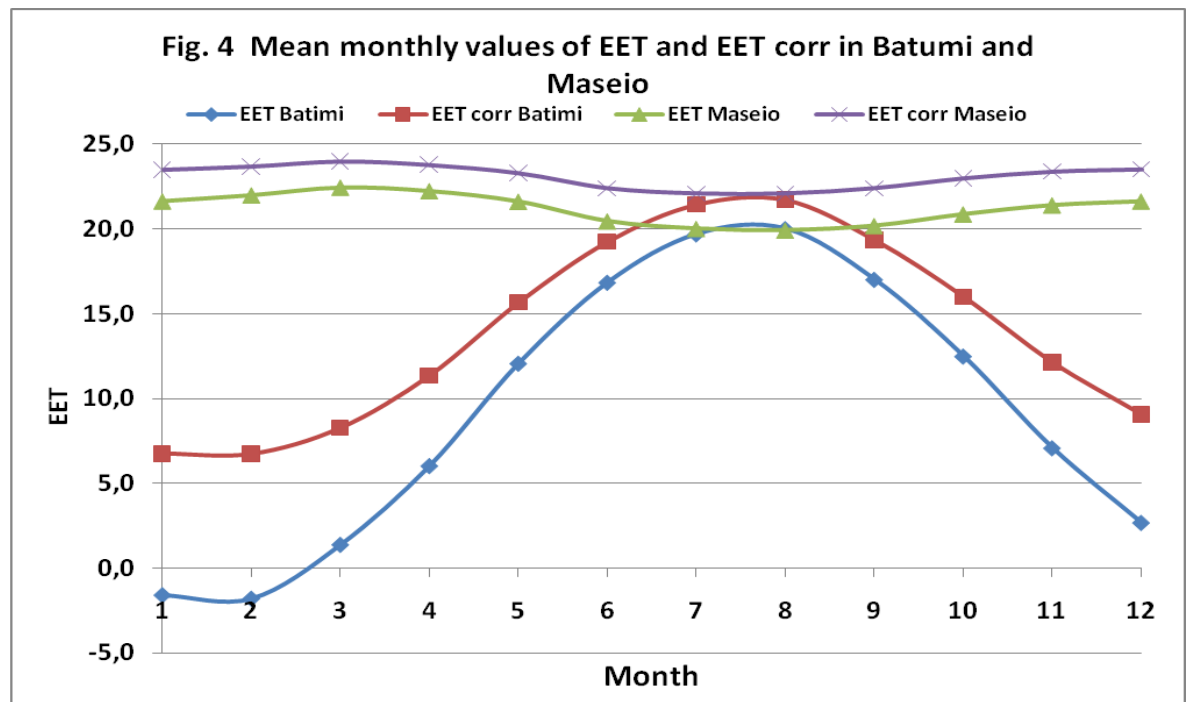
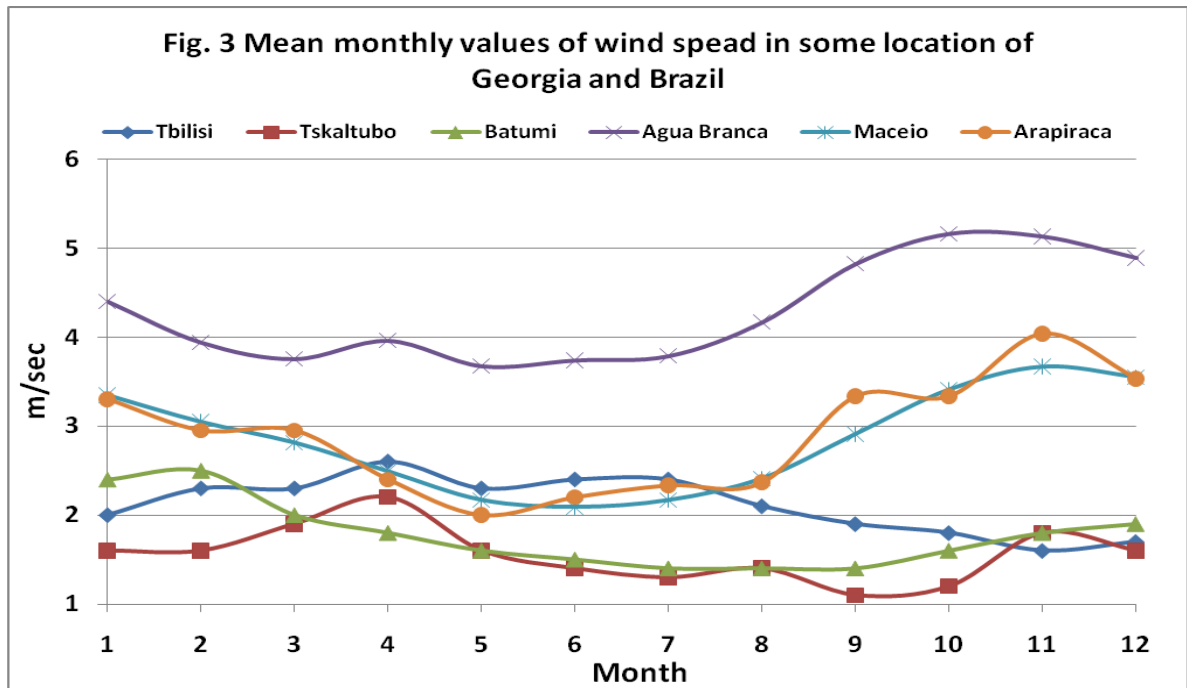


Fig. 1-3 the intra-annual distributions of the mean monthly values of separate components of EET for some cities of Georgia and Brazil are presented. As follows from fig. 1 the mean monthly values of temperature in Tbilisi, Tskaltubo, Batumi, Agua Branca, Maceio and Arapiraca only in June, July, August and September are close to each other. In the remaining months essential difference in the values of temperatures is observed. Thus, during January this difference reaches 25.2°C (Tbilisi - Arapiraca).

The mean monthly values of relative humidity in Agua Branca, Maceio and Arapiraca into entire above, but are commensurate with values of relative humidity in Tskaltubo and Batumi (fig. 2). The greatest difference in the values of the air relative humidity is noted for Tbilisi and Agua Branca. For example, during July this difference reaches 35%. But in December the values of the air relative in Tbilisi and Agua Branca are equal (75%).

The data about the mean monthly values of wind speed for Tbilisi, Tskaltubo, Batumi, Agua Branca, Maceio and Arapiraca are represented in fig. 3. The greatest values of wind speed in Agua Branca are observed, the smallest – in Tskaltubo and Batumi. For example, the mean annual values of wind speed are equal: Tbilisi – 2.1m/sec, Tskaltubo – 1.6 m/sec, Batumi – 1.8 m/sec, Agua Branca – 4.3 m/sec, Maceio – 2.8 m/sec and Arapiraca – 2.9 m/sec.

Finale, in fig. 4 the data about the mean monthly values of EET and EET corr for Batumi and Maceio are presented. Into Maceio values of EET during the year change insignificantly, from 19.9° (August) to 22.5° (March) - practically entire year comfortable temperature is observed. In Batumi values of EET change in the much larger limits, from -1.8° (February) to 20.0° (August) - practically only four months (June – September) on the average are comfortable. Let us note, that in Tbilisi values of EET change from -10.1° (January) to 19.4° (July, August) and practically only these two months on the average are comfortable.

Into Maceio values of EET corr during the year also change insignificantly, from 22.1° (July, August) to 24.0° (March) – “Comfortable” and “Warmly” temperature. In Batumi values of EET corr change from 6.7° (January, February) to 21.7° (August). As for EET - practically four months (June – September) on the average are “Comfortable”.

4. CONCLUSIONS

The comparative analysis of mean monthly values of the air Equivalent-Effective Temperature for 7 cities of Georgia and Brazil (state Alagoas) is carried out. The essential difference in the contrast of space and temporary values of EET in these countries is noted. In Brazil the values of EET and EET corr change insignificantly from “Comfortably” to “Warmly”. In Georgia the values of EET and EET corr change over a wide range - from “Sharply coldly” to “Comfortably”. Similar studies can be useful for the optimization of the activity of health resort-tourist industry.

ჰაერის ექვივალენტურ-ეფექტური ტემპერატურის ფარდობითი ანალიზი საქართველოს და ბრაზილიის ზოგიერთ ქალაქში

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რეზიუმე

ადგილის ბიოკლიმატური მახასიათებლების შეფასება ხშირად წარმოებს ექვივალენტურ-ეფექტური ტემპერატურის მეთოდით (ეეტ). ეეტ – ერთდროულად დაკვირვებული ტემპერატურის, ჰაერის ფარდობითი ტენიანობის და ქარის სიჩქარის ერთობლიობაა, რომელიც გამოხატულია ტემპერატურის პირობითი მნიშვნელობით. ეეტ ქმნის იგივე თბომეგრძნებას, როგორც ქმნის უძრავი ჰაერი 100% ტენიანობისას გარკვეულ ტემპერატურაზე. გამოყოფენ ეეტ-ის ექვს ძირითად გრადაციას: < 1 - ძალიან ცივა, 1-8 - ცივა, 9-16 - ზომიერად ცივა, 17-22 - კომფორტულია, 23-27 - თბილა, > 27 - ცხელა.

მოყვანილია ეეტ-ის საშუალოთვიური მნიშვნელობების ფარდობითი ანალიზი საქართველოსა და ბრაზილიის (ალაგოასის შტატი) 8 ქალაქისათვის. აღინიშნება ეეტ-ის სივრცულ-დროითი მნიშვნელობების კონტრასტულობის მნიშვნელოვანი სხვაობა ამ ქვეყნებში. ასე მაგალითად, მასეიოში ეეტ-ი წლის განმავლობაში იცვლება უმნიშვნელოდ, 19.9 (აგვისტო)-დან 22.5 -მდე (მარტი) – პრაქტიკულად მთელი წლის განმავლობაში კომფორტული ტემპერატურაა. თბილისში

ექტ-ის მნიშვნელობები იცვლება საგრძნობლად უფრო დიდ ფარგლებში, -10.1 -დან (იანვარი) 19.4 - მდე (ივლისი, აგვისტო) – პრაქტიკულად ეს ორი თვე წარმოადგენს კომფორტულს. ასეთი გამოკვლევები სასარგებლო იქნება საკურორტო-ტურისტული ინდუსტრიის საქმიანობის ოპტიმიზაციისათვის.

საკვანძო სიტყვები: ექვივალენტურ-ეფექტური ტემპერატურა, ბიოკლიმატი.

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