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From Knowledge to Wisdom

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Analysis of Storm Pattern for Design Urban Drainage System in the Monsoon Areas of Vietnam

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Abstract: In Vietnam, rainfall data usually received using daily rainfall at all hydrology stations with higher time resolution are scarce. However, its analyses to achieve IDF (Intensity-Duration-Frequency) curves are often required at a finer scale such as hourly. Therefore, it needs to develop and apply methods to derive the IDF characteristics of short-duration events from daily rainfall statistics in Vietnam. In recent years, the need for new insights into the rainfall process leading to new approaches to model the distribution of rainfall intensities in time and space was recognized. This research aims to establish IDF curves for monsoon climate area in Vietnam based on scaling method. Scaling properties of extreme rainfall are examined in the Red River Delta of Vietnam in order to establish scaling behavior of statistical moments over different durations. Such scaling or scale-invariant models enable us to scale data from one temporal resolution to another, and thus, help to overcome the lack of the extreme rainfall data of sub-daily durations. The disaggregation or downscaling techniques are used to obtain sub-daily rainfall data from daily rainfall data for the derivation of scaled IDF curves. Research results show that most of rainfall amount (approximately 70%) received from rains occurring between 6:0 pm to 6:0 am of the day after that, the daytime usually less rainfall occurrence with only 30%. The peak rainfall is usually occurred during 0:0 am to 4:0 am having approximately 42.98% of rainfall amount over a day. The peak rainfall likely happen earlier in the recent year (36% rainfall amount over a day occurrence from 6:00 pm to 10:00 pm in 2008). The analysis also illustrated that approximately 40% of rainfall events have duration less than 60 minutes. In contrast, only approximately 9% of rainfall events have duration more than 6 hours but total rainfall depths of these events is approximately.

Key word: IDF (Intensity-Duration-Frequency) curves, design rainfall for urban, design rainfall in the Monsoon areas.

1. Introduction

Vietnam has been significantly urbanized in recent years. The process of urbanization has been happening pretty soon from the medieval with the formation of feudal city, but for many reasons, that process took slowly and low level of residential development urban. However, in the last of twentieth century and beginning of twenty first century open up a new development of urbanization in Vietnam with growth of economic and rapidly increase of population associated which is formed on large scale, bulk, speed, industrial parks, export processing zones, new urban areas and significant improvement of infrastructure in both urban and rural areas.

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Over the last 20 years, Vietnam has undergone a dramatic period of urbanization and the national urban system has been experiencing many changes. In 1990, there were only about 500 urban areas nationwide, but by 2000 this figure had increased to 649 and by 2003 it had reached 656. The current urban system consists of 753 urban areas, including the two special urban areas of Ha Noi and Ho Chi Minh City. According to census data, during this period the proportion of people living in urban areas increased from 23.7% in 1999 to 29.6% in 2009 and one third of urban population are living in Ha Noi and Ho Chi Minh City, where are the cities expecting to triple by 2020. The urbanization rate is 3.06% per annum and expected more (Urbanization in Vietnam: Evidence from the 2009 census, UNFPA report 2004).

The rapidly increasing of population and expand of

urban areas while low investment of drainage infrastructure lead to more flooding occurs which has become in urban areas of Vietnam. Urban areas are requiring the protective structures, which can prevent or mitigate the occurrence of flood with the minimum costs. That is the most survival important of development and urbanization of Vietnam.

The IDF (Intensity-Duration-Frequency) relationship of heavy rainfall is one of the most important tools utilized by engineers for designing flood alleviation and drainage structures in urban and urban areas. The establishment of such relationship was done as early (eg., Sherman, 1931; Bernard, 1932). Since then, many sets of relationship have been constructed for several parts of the globe (e.g., Dickinson, 1977; Kothyari and Garde, 1992; Froehlich, 1995; Ferro and Bagarello, 1996). However, such relationships have not been constructed in Vietnam [1, 2].

There is a high need for establishment of the IDF curves in Vietnam.

Local IDF equations are often estimated on the basis of records of intensities abstracted from rainfall depths of different durations, observed at a given recording rainfall gauging station.

In Vietnam, rainfall data usually received using daily rainfall at all hydrology stations and rainfall data at higher time resolution are scarce. However, rainfall data analyses to achieve IDF curves are often required at a finer scale such as hourly rather than daily. Therefore, it needs to develop and apply methods to derive the IDF characteristics of short-duration events from daily rainfall statistics in Vietnam.

In recent years, the need for new insights into the rainfall process leading to new approaches to model the distribution of rainfall intensities in time and space was recognized. Therefore, the study aims to establish IDF curves for monsoon climate area in Vietnam based on scaling method. Scaling properties of extreme rainfall are examined in the Red River Delta of Vietnam in order to establish scaling behavior of statistical moments over different durations. Such scaling or scale-invariant models enable us to scale data from one temporal resolution to another, and thus, help to overcome the lack of the extreme rainfall data of sub-daily durations. The disaggregation or downscaling techniques are used to obtain sub-daily rainfall data from daily rainfall data for the derivation of scaled IDF curves.

2. Methodology

2.1 Rainfall Measurement

Rainfall are measured by rain gauge and measured in term of depth, the values being expressed in inches or millimeters. Rain gauges are based on the simple idea of exposing in the open hollow cylindrical vessel with a bottom.

Rain gauge is the standard method collection. Based on the types of rain collection, the rain gauges are classified as: Standard rain gauge, Weighing precipitation gauge, Tipping bucket rain gauge, Optical rain gauge and Aucoustic rain gauge. Rain gauges are located to collect rain over a specified area, based on time of recording rainfall data will classified rain gauge to be: Daily rain gauge, Recording rain gauge and Tipping bucket rain gauge.

Most Hydrometeological Stations in Vietnam is using Optical rain gauges to recording rainfall data. The rainfall data is collected and saved in graphs as shown in Figs. 1, 2.

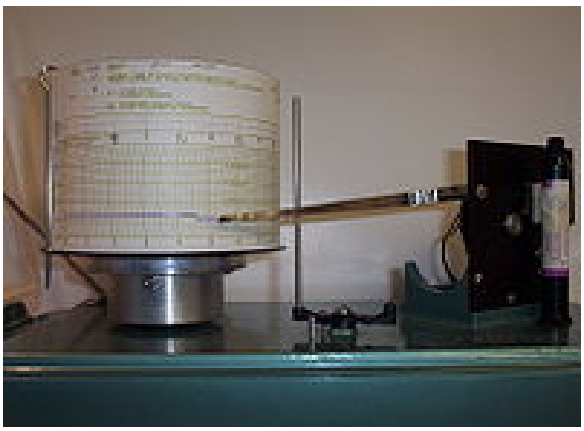


Fig. 1 Tipping bucket rain gauge recorder.

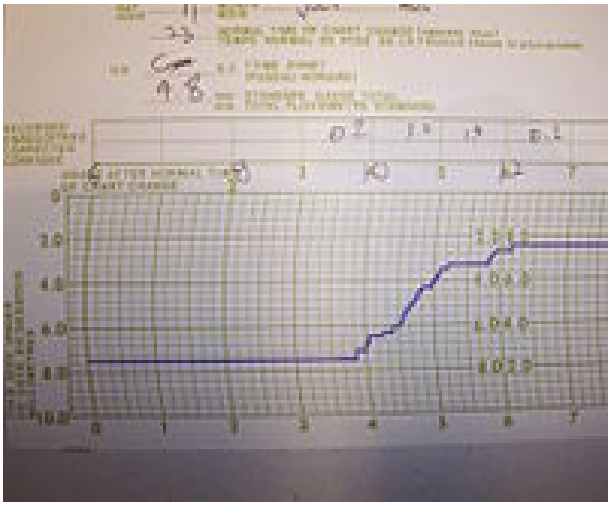


Fig. 2 Close up of a tipping bucket rain gauge recorder chart.

This research collected the rainfall data from two sources:

First one is the rainfall recorded at AIT meteorological station and WEM rain gauge, which can be recorded at minimum resolution of 1 minute. Rainfall data has recorded over period from 1990 to 2009.

Second one is rainfall data of Vietnam. The 30 year records (from 1956 to 1985) annual maximum daily rainfall were taken from Vietnam Institute of Meteorology and Hydrology (VNIMH). Five year hourly rainfall data of Lang Station (Ha Noi Capital) including 1984, 1995, 1996, 2002 and 2008 were available and collected.

2.2 Rainfall Characteristics

2.2.1 Frequency Analysis

The frequency analysis of rainfall data is meant to derive information from the historical. From the frequency analysis, estimates of magnitude of future events can be obtained.

2.2.2 Return Period

The recurrence interval or return period of a storm is the average time interval, usually in years, during which the given storm is likely to be equal or exceeded. The lengths of return periods from 2 years to 100 years are typically used for practical case. In this study, 2, 5, 10, 25, 50, 100 and 200 years return period are used.

2.2.3 Distribution of Extreme Values

There are many distributions which are commonly used to represent the distribution of maximum values. These distributions were can be used for fitting the maximum values: Gamma Distribution, Normal Distribution, Lognormal Distribution, Extreme Value Type I or Gumbel Distribution, Pearson Type III Distribution, Log Pearson Type III Distribution.

2.2.4 Storm Duration

The storm duration remains a problem for design engineers because of no accepted guidelines exist to define an appropriate duration. Watt, W. E. [3] concluded that for most small urban areas (up to 50 ha), the storm duration of 1 hour is quite suitable.

2.2.5 Depth-Duration-Frequency Curve

For any storm duration, one maximum value from every year will be selected to develop annual maximum series. Theoretically, The plotting of annual maximum rainfall and corresponding return period on extreme likelihood paper gives the Depth-Duration-Frequency curve which are the tails of the rainfall depth frequency distribution for various durations of storm.

2.2.6 Intensity-Duration-Frequency Curve

Rainfall Intensity-Duration-Frequency relationship gives the probability of obtaining rainfall intensity larger than specified intensity for a given duration. It can be determined from Depth-Duration-Frequency Curve by divided depth of rainfall by its considered duration.

Rainfall intensity duration frequency relationship comprises the estimates of rainfall intensities of different durations and recurrence intervals. The typical technique for establishment the IDF curves of precipitation is conducted via three steps.

2.3 Single-site Temporal Disaggregation Model

Because of daily precipitation data is most accessible and abundant source of rainfall information,

it seems natural, at least for the regions where data at higher time resolution are scarce, to develop and apply methods to derive the IDF characteristics of short-duration events from daily rainfall statistics. In this regard and in contrast to earlier empirical disaggregation techniques, the works of Burlando, P. and Rosso, R. [4], Menable M. [5] and Nhat, L. M. [6] are examples of methodologies in which the theories of scaling properties and employed to infer the IDF characteristics of short-duration rainfall from daily data.

2.3.1 Model Description

Definition of disaggregation;

Generation of synthetic data (typically using stochastic methods);

Involvement of two scales (higher- and lower-level);

Use of different models for the two time scales (with emphasis on the different characteristics appearing at each scale);

Requirement that the lower-level synthetic series is consistent with the higher-level on;

Hyetos: A single variate fine time scale rainfall disaggregation model based on the modified Bartlett-Lewis process.

Modified Bartlett-Lewis (MBL) rectangular pulse model was considered due to its wide applicability for describing various different climates by Rodriguez-Iturbe, I., et al. [7]. The diagram atic explanation of the MBL is depicted in Fig. 3.

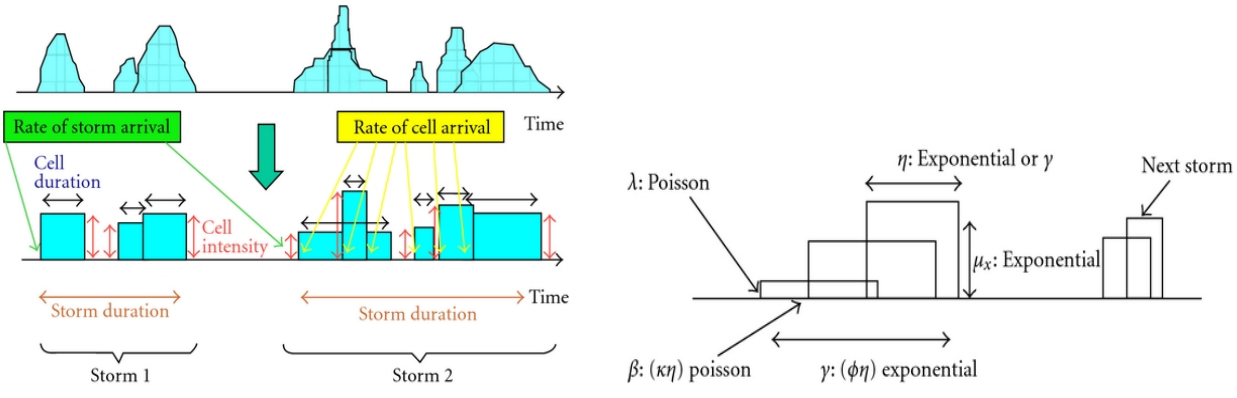
2.3.2 The Hyetos Model

Hyetos is a package for the temporal stochastic simulation of rainfall process at fine time scales based on Bartlett-Lewis rectangular pulses rainfall mode.

This combines a rainfall simulation model based upon the Bartlett-Lewis process with proven techniques developed for the purpose of adjusting the finer scale (hourly) values so as to obtain the required coarser scale (daily) values. The methodology directly answers the question of the possible extension of the short hourly time-series with the use of longer-term daily data at the same point and provides the theoretical basis for an operational use of this methodology when no hourly data are available.

Repetition is first carried out to derive a synthetic rainfall series, which resembles the given series at the daily scale. This step focuses on the wet/dry pattern and the intensities separately. In a second step, an appropriate adjusting procedure—the proportional adjusting procedure—is applied to make the generated hourly series fully consistent with the given daily series without affecting the stochastic structure implied by the model.

The essential elements of the dynamic disaggregation model, described in detail by Koutsoyianis, D., et al. [8].



(a) (b)

Fig. 3 (a) Explanatory sketch for the structures of rainfall storms; (b) Explanatory sketch for the parameters of Bartlett-Lewis rectangular pulses model.

The disaggregation of a high-level variable, Y into its k components (low-level variables, Yi, i=1… k), is performed in k-1 sequential steps.

At the beginning of the ith step, the amount-still-to-go, Si, is known, and Xi is generated. The remaining quantity Si+1=Si – Yi is transferred to the next step.

In each step, the distribution function (Yi, Si), conditional on previously generated information, is determined or approximated via conditional moments. It is assumed that the sequence of Yi has certain properties allowing the calculation of conditional moments, e.g. it is am autoregressive sequence.

The generation of Yi is performed by the so called bisection procedure, which can take several forms depending on the particular marginal distribution of the low-level variables.

2.4 Scale Invariance Properties of Rainfall in Time Series

The scaling or scale-invariant which enable to transform data from one temporal or spatial model to another one, thus help to solve the difficulty of inadequate data. A natural process fulfills the scaling property if the underlying probability distribution of some physical measurements at one scale is identical to the distribution at another scale, multiplied by a factor that is a power function of the ratio of two scales. The basic theoretical development of scaling has been developed by Gupta and Waymire [9].

2.5 Derivation of IDF for Short Duration

All forms of the generalized IDF relationships assume that rainfall depth or intensity is inversely related to the duration of a storm raised to a power, or scale factor 6. There are several commonly used functions found in the literature of hydrology applications. Koutsoyiannis, D., et al. [8] have modified the IDF relationship for a given return period as particular cases, using Eq. (1):

$$i = \frac{w}{(d+\theta)^{\eta}} \tag{1}$$

Where I denotes the rainfall intensity for duration d and w, θ and η represent non-negative coefficients. In fact, these arguments justify the formulation of Eq. (2) for the IDF relationships:

$$i = \frac{a(T)}{b(d)} \tag{2}$$

2.6 Empirical IDF Formulas

The IDF formulas are the empirical equations representing a relationship among maximum rainfall intensity (as dependant variable) and other parameters of interest such as rainfall duration and frequency (as independent variables). There are several commonly used functions found in the literature of hydrology applications [10] based on four form of equations used to describe the rainfall intensity duration relationship are summarized as Eqs. (3-6):

Talbot equation:

$$i = \frac{a}{t_d + b} \tag{3}$$

Bernard equation:

$$i = \frac{a}{t_d^c} \tag{4}$$

Kimijima equation:

$$i = \frac{a}{t_d^c + b} \tag{5}$$

Sherman equation:

$$i = \frac{a}{(t_d + b)^c} \tag{6}$$

Where i is the rainfall intensity (mm/hour); t_d is the storm duration (minutes); a, b and c are the constant parameters related to the metrological conditions.

These empirical equations show rainfall intensity decreases with rainfall duration for a given return period. All functions have been widely use for hydrology practical applications. The least-square method is apply to determine the parameters of the four empirical IDF equations that are use to represent intensity duration relationships. The value of parameters in the rainfall IDF equations are chose on minimum of RMSE (Root Mean Square Error) between the IDF relationships produce by the frequency analysis and simulate by the IDF equation.

2.7 Design Storm Pattern

Design storm is a rainfall event, which is developed for the design of specific type of objects, such as drainage systems or retention basins. There are several rainfall pattern used in many countries.

The main objective of this study is that to propose an optimal and suitable temporal rainfall pattern for urban drainage design in Vietnam. The main difficulty related to the determination of a suitable storm pattern for design purposes has been confirmed by the availability of various synthetic design storm models developed and used around the world. The Chicago model was the first developed in U.S. by Keifer, C. J. and Chu, H. H. [11] in 1957, and it was followed by other alternatives such as the pattern proposed by Sifalda, V. [12], Yen, B. C. and Chow, V. T. [13] and the balanced model suggested by the U.S. Army Corps of Engineers (1982). In Vietnam, rainfall design is not identical and there are also several methods such as: experimental model by Ministry of Construction, models based on formulas by Russia, Europe Union etc..

There are two main types of synthetic design storm, one is design storm derived from IDF relationships and the other one is design storm resulted from analyzing and synthesizing the characteristics of historical storm data. Based on these types of design storm, different synthetic design storm models available in various countries all over the world:

US Chicago storm model pattern by Keifer, C. J. and Chu, H. H. [11];

US Normalized storm pattern by Huff, F. A. [14];

Czechoslovakian storm pattern by Sifalda, V. [12];

US storm pattern by Yen, B. C. and Chow, V. T. [13];

Canadian temporal rainfall patterns by Nguyen, V. T. V. [15];

Canadian storm model by Watt, W. E., et al. [3].

In this study, Chicago design storm, Silfada, V. [15] design storm will be apply at the monsoon areas of Thailand and Vietnam. This method described by Keifer, C. J. and Chu, H. H. [11] uses IDF curves for design hyetograph at given location. In general, the purposed storm pattern is fitted to exponential growth and decay curves with the intense part of the storm defined by a parameter, storm advance coefficient. This method was developed in Chicago for urban sewer design but can easily be used in other areas where adequate rainfall records are available.

3. Data Analysis

3.1 Data Collection

This study collected the rainfall data from two sources. First one is the rainfall recorded at AIT meteorological station and WEM rain gauge, which can be recorded at minimum resolution of 1 minute, and length of record during the period from 1990 to 2009.

Second one is rainfall data of Vietnam. The 30 year records (from 1956 to 1985) annual maximum daily rainfall and were taken from VNIMH (Vietnam Institute of Meteorology and Hydrology).

Five year include 1984, 1995, 1996, 2002 and 2008 when heavy rainfall occurred, hourly rainfall data is available but only in Lang Station, which is located in Ha Noi capital. The length of record for recording rain gauges is list in Table 1, and the position of rain gauges presented in Fig. 4 as shown.

Rainfall data in Vietnam was recorded in 7 stations where are located in the whole Red River Delta in

Vietnam. The Red River and Thai Binh River systems are two main river systems in the North of Vietnam have a basin area of 169,000 km^2 (Fig. 4). The Red River Delta area is 5,540 km^2, annual rainfall strongly varies over the Red river area in a range 1,200-2,500 mm/year.

Seven rainfall stations includes Lang, Bac Giang, Hai Duong, Thai Binh, Nam Dinh, Ninh Binh and Van Ly which are located in the Red River Delta (Fig. 5) was collected.

3.2 Analysis of Rainfall Characteristics in Lang Station

3.2.1 The Percentage of Rainfall Depth

The percentage of rainfall depth in a day for each year is calculated based on the average percentage of rainfall depth of 4 years 1984, 1995, 1996, 2002 and 2008 which are the year with very high value of extreme rainfall and hourly rainfall data available at Lang Station (1984 and 2008, total rainfall depth are 2,189 mm and 2,276 mm respectively).

Table 1 List of recording rain gauges.

Station	Latitude	Longitude	Elevation	Duration	No of year record
Lang	21°01’	105°48.0’	5.2		
Hai Duong	20°5.6’	106° 18.8’	3.2		
Bac Giang	21°17’	106°12’	7.1		
Thai Binh	20°2.7’	106°21.8’	2.3	24-hour	30 years (1956-2085)
Nam Dinh	20°2.6’	106°10.8’	2.1		
Ninh Binh	20°1.4’	105°58.8’	3.6		
Van Ly	20°02’	106°30.0’	2.3		

Source: Vietnam Institute of Meteorology and Hydrology.

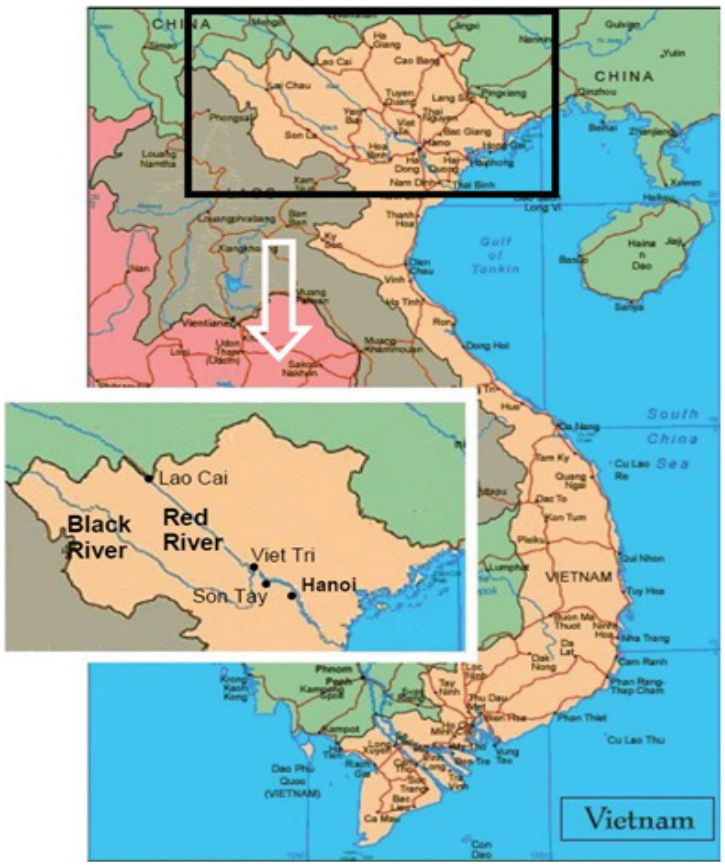


Fig. 4 Location of Red River Delta—Vietnam.

Fig. 5 Record rain gauges network map (rectangular shape is rain gauges stations).

Average percentage of rainfall depth over a day shows that the rainfall usually occurs from 18:00-6:00 with more than 70.0%, and during 9 hour of day time from 07:00-17:00, rainfall not much occurs only 30.0%. And one peak time of 1984 at 2:0 am with 13.3% of rainfall amount occurs and the other in 2008 at 20:0 with 9.05%.

3.2.2 Distribution of Rainfall Duration

The annual number of storms occurred in Lang Station usually varies between 261 and 350. The total annual rainfall depth range from 1,200 to 2,500 mm, the average annual rainfall is 1,662.4 mm during the period form 1956 to 1985. The maximum monthly rainfall depth recorded in Lang is 664.8 mm (Aug. 1972).

There are 5 year (1984, 1995, 1996, 2002 and 2008), which were the year with more flood occurred in Ha Noi, therefore hourly was available and used for many research in order to study about flooding.

In 1984, there were 326 storms was occurred and total rainfall depth was 2,189 mm. There were 5 days with total daily rainfall depth more than 100 mm and special in 9th Nov. 1984, has an storms with total depth is 573.9 mm. Both of this extreme value occurred in the same storm, 10th Nov. 1984 total depth of this event is 413 mm (18.9% of total rainfall depth this year) with 31 hour of duration.

There is a significantly change in rainfall characteristics in Lang Station in comparison between 1984 and 2008. Consider the period from 1984 to 2008, Fig. 6 clearly show that the number of storm events which has storm duration more than 6 hours is decrease (10.4% to 8.8%). In contrast, amount of these storm events increase from 59.7% to 64.8%. It seems like that more extreme rainfall occurrence in the recent years, potently leading to more flood in Ha Noi Capital.

The research result show that the storm event occurred at 10th November 1984 which recorded in Lang Station with peak was 163.3 mm, storm duration was 31 hour and rainfall depth was 413 mm. The storm event occurred at 19th September 1984 which

Table 2 Number of storm and total rainfall depth in Lang Station in 1984.

Duration (hr)	Number of storm	Total depth (mm)	Percentage of storm events (%)	Percentage of depth (%)
<1 hr	139	112.9	40.4	5.2
2 hr	83	186.8	24.1	8.5
3 hr	34	161.1	9.9	7.4
4 hr	19	268.4	5.5	12.3
5 hr	35	153.5	10.2	7.0
6 hr	13	65.6	3.8	3.0
>6 hr	21	1,240.4	6.1	56.7
Total	344	2,189	100%	100%

Table 3 Number of storm and total rainfall depth in Lang Station in 2008.

Duration (hr)	Number of storm	Total depth (mm)	Percentage of storm events (%)	Percentage of depth (%)
<1 hr	122	112.9	41	5
2 hr	66	209.5	22	9
3 hr	35	212	12	9
4 hr	21	75	7	3
5 hr	27	632.6	9	28
6 hr	9	192.1	3	8
>6 hr	18	841.7	6	37
Total	298	2,276	100%	100%

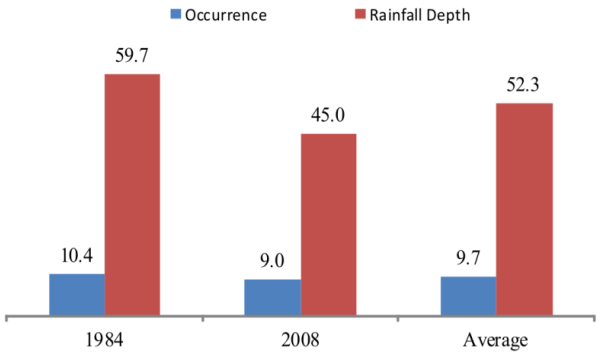


Fig. 6 Percentages of storm duration more than 6 hours in 1984/2008.

recorded in Lang Station with peak was 66.5 mm, storm duration was 10 hour and rainfall depth was 217.2 mm. The storm event occurred at 17th July 2008 which recorded in Lang Station with peak was 47.3 mm, storm duration were 5 hours and rainfall depth was 130.9.2 mm. In 2008, total rainfall depth was 2,276 mm and there were 2 days with total rainfall depth more than 100 mm per day. The maximum daily and hourly rainfall depths were 391.2 and 69.9 mm respectively. Also, both of this extreme value occurred in the same storm, 31st Oct. 2008. The storm event occurred at 17th July 2008 which recorded in Lang Station with peak was 47.3 mm, storm duration were 5 hours and rainfall depth was 130.9.2 mm.

3.2.3 Analysis Trend of Annual Total Rainfall Depth at Lang Station from 1956 to 1985

The relationship between annual rainfall depths from 1956 to 1985 and years which is expressed in Equation below:

Annual total rainfall depth: $Y = 0.602X^2 - 5.0433X + 1506.3$

The trend shows that annual rainfall significantly increased during the period from 1956 to 1985 as shown in Fig. 7.

According to available rainfall depth data during the period from 1956 to 1985 in Hanoi presented in this chart, we can see that the trend annual rainfall is increasing and ranging from 1,200 to 2,500 (mm/year) as shown in Fig. 8.

3.3 Disaggregation of Daily Rainfall into Hourly Depths

Hyetos is a package for the temporal stochastic simulation of rainfall process at fine time scales based on Bartlett-Lewis rectangular pulses rainfall mode. A simple and generic model that performs disaggregation of daily into hourly rainfall is presented. It combines an existing rainfall simulation model of the Poisson cluster type along with an appropriate technique for modifying the rainfall model output, thus performing disaggregation. Specifically, it uses the Bartlett-Lewis rectangular pulses rainfall model as a background stochastic model for rainfall generation.

The daily rainfall data used were taken from VNIMH (Vietnam Institute of Meteorology and Hydrology). The annual rainfall is varying from 1,200-2,500 mm/year, with a yearly total of between 121 and 185 days with rain. For the simulation of the

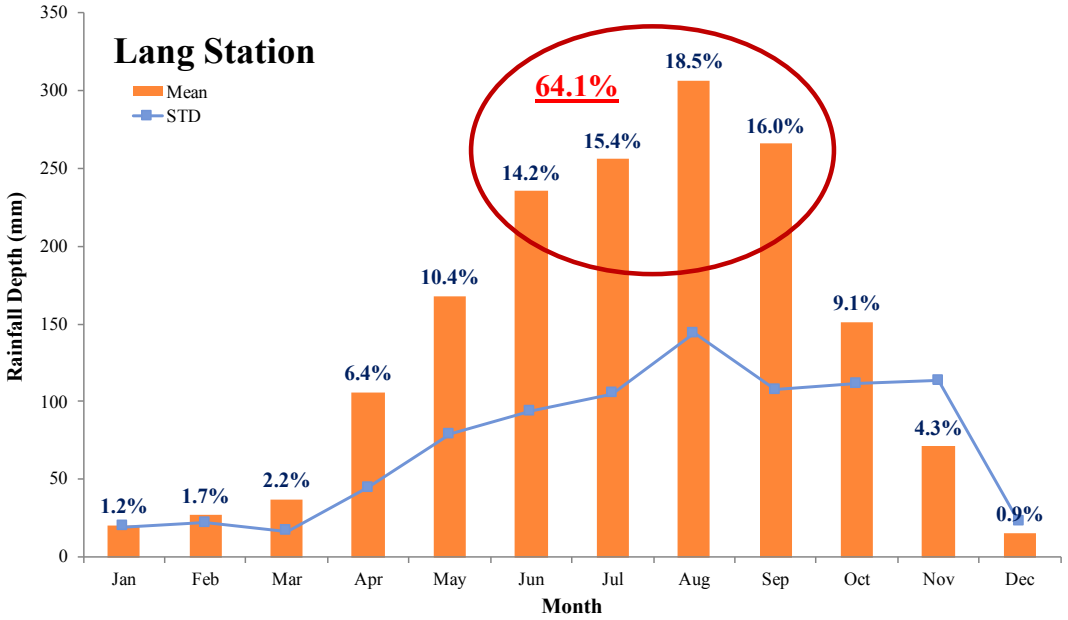


Fig. 7 Average monthly rainfall depth in Lang Station during the period 1956-1985.

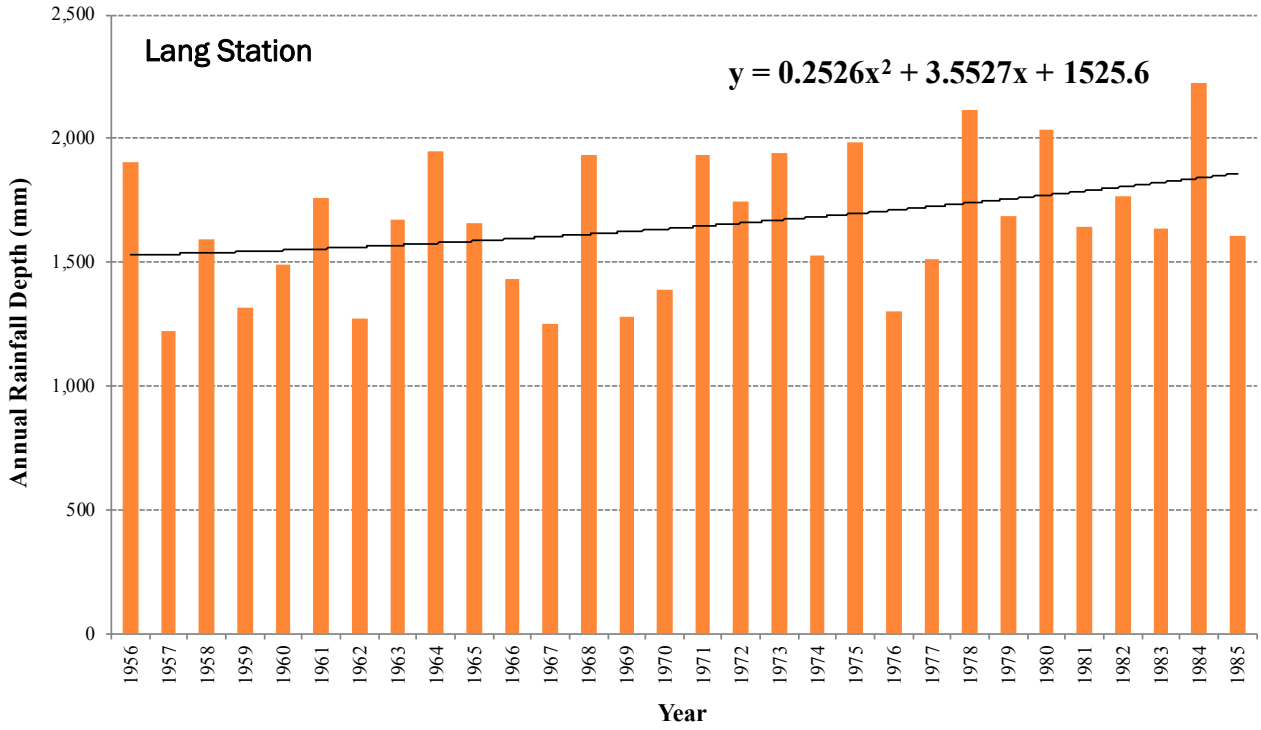


Fig. 8 Annual rainfall depth in Lang Station from 1956 to 1985.

series of hourly rainfall the stochastic model adopted was the modified Bartlett-Lewis rectangular pulse model with 6 parameters. The resolution of the hourly data was of the order of 0.1 mm, and whenever the precipitation observed during an interval of time was less than this, the interval was defined as dry. To consider the seasonal variance of the values of precipitation, the parameters of the model are estimated separately for each month. The set of five parameter for the model has estimated and is shown in Table 4.

Table 4 Parameter estimation for hyotes model estimation.

Station	κ (Kappa)	Λ (lambda)	Ψ (psi)	η (eta)	θ (theta)
Lang	0.15	15.74	4.00	0.779	0.289
Nam Dinh	0.15	16.29	3.31	0.749	0.259
Thai Binh	0.15	16.48	3.38	0.696	0.184
Hai Duong	0.15	15.37	4.20	0.768	0.279
Bac Giang	0.15	14.67	3.98	0.810	0.259
Ninh Binh	0.15	16.57	3.38	0.751	0.260
Van Ly	0.15	16.79	3.39	0.189	0.189

From daily rainfall depth, five parameters of the model including above were estimated as in Table 4, by applying Hyetos model, research had disaggregate annual maximum daily rainfall depth to sub-daily rainfall data. Fig. 9 is annual maximum rainfall depth for various durations from one hour to 24 hours.

3.4 Establishment of IDF Curves

In order to examine the time scale invariance of rainfall, the analysis was performed on annual maximum rainfall series for storm durations from 1 hour to 24 hours, with λd = 1, 2...24. For each year the E[id] measure is calculated for fixed values q = 0, 1, 2, 3, 4 and 5. Then, for each q the ensemble average is calculated over the length of data record. The scaling properties of average singular measures are tested. By fitting with a line of $E\left[I_d^q\right]$ versus durations in log-log plot we obtain the value of the K(q) function for fixed q. It is shown in Fig. 10.

Fig. 11 shows the relationships between the log-transformed values of moment of various orders against values durations. For all four stations, the straight-line behavior with the R2 is equal 0.1. The slope of the regression line between K(q) and q is η = 0.7495, as an estimated for the scale factor.

Table 5 shows that The IDF relationship for short duration rainfall can be deduced from daily data with η = 0.7495 for Lang Station and with the estimates of μD and σD with D = 24-hours. From 24-hour data collected at the Lang recording gauge Station, the sample of 21 year of 24-hour annual maximum rainfall intensity yields. The estimates μD = 24 = 5.75 and σD = 24 = 2.00, and then $\mu = \lambda^{\eta}\mu_{24} = 48.71$ and $\sigma = \lambda^{\eta}\sigma_{24} = 21.68$.

Annual maximum rainfall depth for 2, 5, 10, 25, 100 and 200 years return period for the particular duration at Lang Station was calculated based on IDF relationships and expressed in Table 6.

Based on this equation, the parameter for 8 stations were estimated and shown in the Table 5. By applying the parameter into the general equation to estimate the

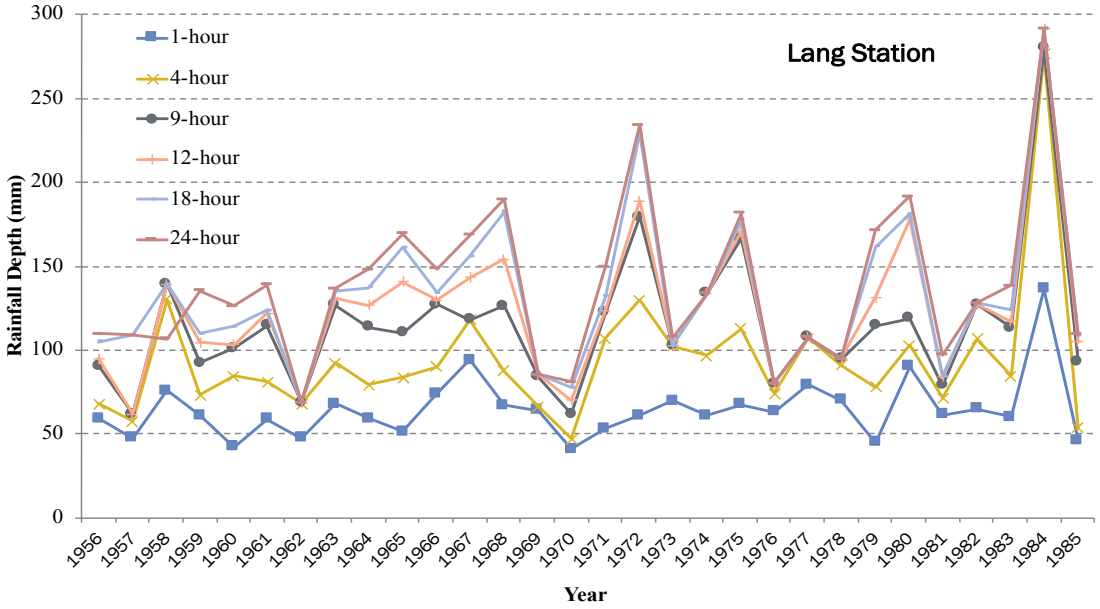


Fig. 9 Annual maximum rainfall depth for various durations.

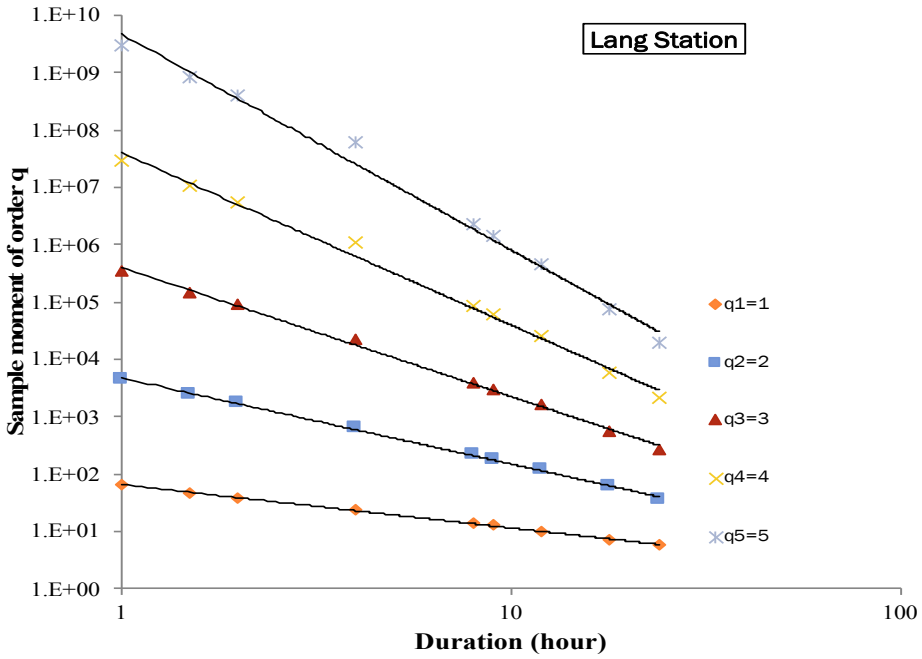


Fig. 10 Relationship between sample moments of order q and duration.

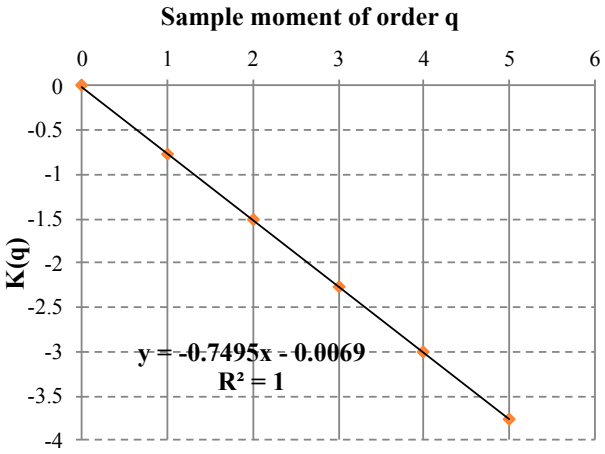


Fig. 11 Sample moments of order q.

Table 5 Parameter of IDF formulas at seven station.

Station	μ	σ	η
Lang	48.71	21.68	0.7495
Nam Dinh	65.09	24.94	0.7769
Thai Binh	50.36	22.44	0.6252
Bac Giang	41.99	20.42	0.7125
Ninh Binh	41.28	22.67	0.5884
Van Ly	50.56	25.29	0.6515
Hai Duong	51.41	18.32	0.6872
WEM-AIT	41.62	3.95	0.803

maximum intensity rainfall for various duration and return period for 8 stations. After that, researchers have achieved the IDF curves which be shown in Fig.12-19.

In order to examine the possibility of applying scale method in other monsoon climate area, Thailand for example, researchers have applied the method with twenty year-maximum-daily rainfall recorded in AIT station. IDF curves are shown in Fig. 19.

3.5 Graphical Evaluation

Another traditional way of constructed rainfall IDF curves by Kimijima Equation. Frequency analysis techniques are used to develop the relationship between the rainfall intensity, storm duration, and return periods from rainfall data.

Table 6 Maximum rainfall depth (mm) for various durations and return period based on IDF relationship at Lang Station.

Duration Return periods	1	2	4	8	9	12	18	24
2	56.66	67.41	80.19	95.39	98.25	105.59	116.88	252.62
5	81.24	96.64	114.96	136.76	140.86	151.38	167.57	180.09
10	97.50	115.99	137.99	164.15	169.07	181.70	201.13	216.16
25	118.06	140.45	167.08	198.76	204.71	220.01	243.53	261.73
50	133.31	158.59	188.66	224.43	231.16	248.43	274.99	295.53
100	148.45	176.60	210.08	249.92	257.40	276.64	306.21	329.09
200	163.53	194.54	231.43	275.31	283.55	304.74	337.32	362.53

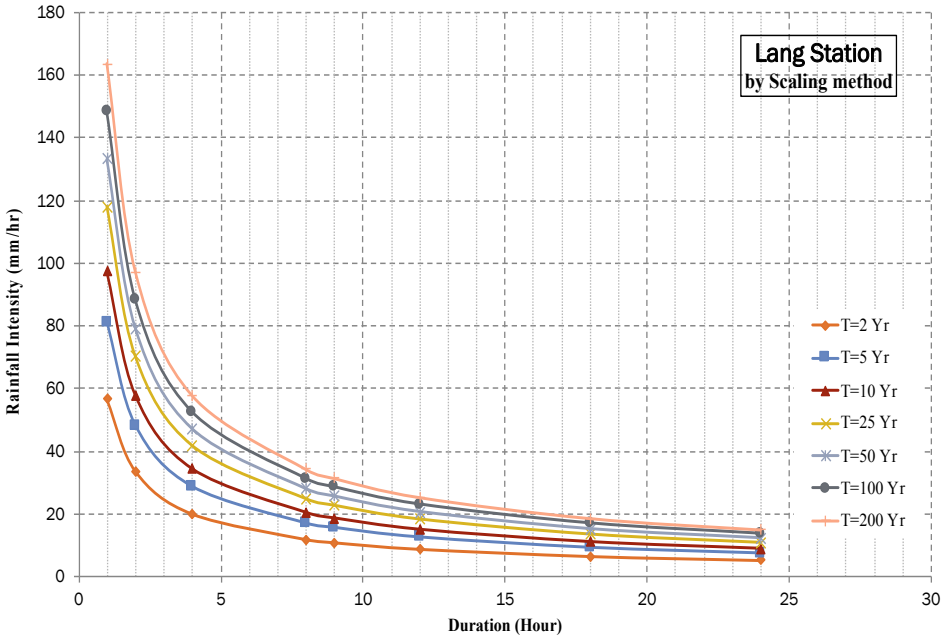


Fig. 12 The Rainfall IDF (Intensity-Duration-Frequency) curves for LANG station by Scaling method.

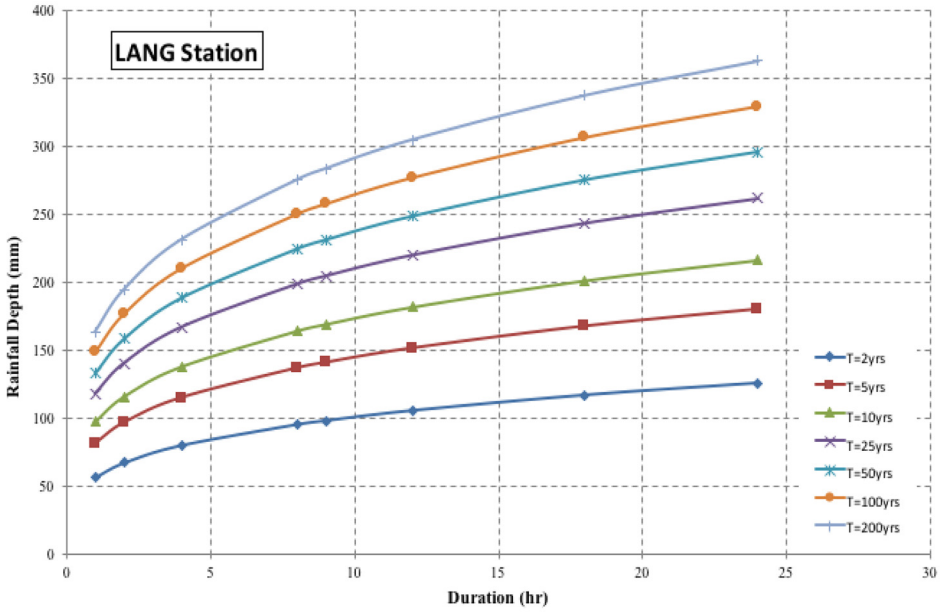


Fig. 13 The Rainfall DDF (Depth-Duration-Frequency) curves for LANG station by Scaling method.

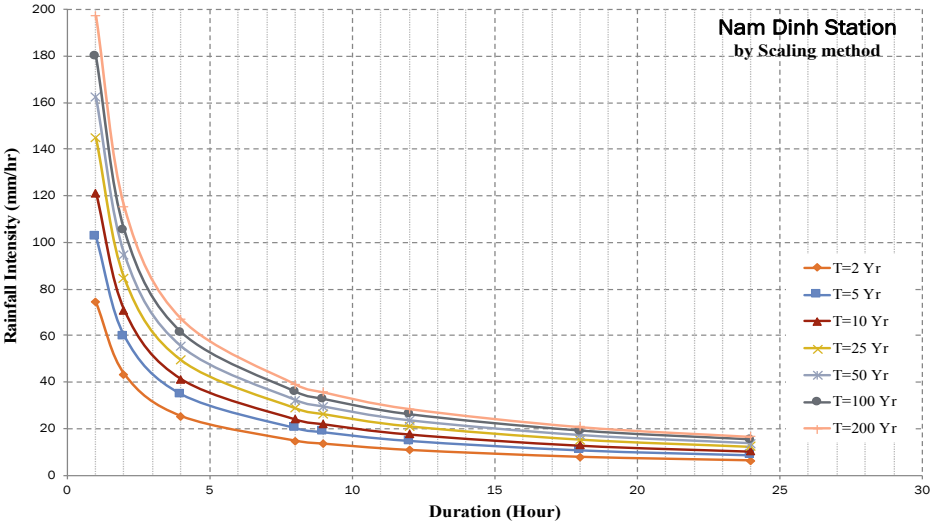


Fig. 14 IDF curves in Nam Dinh Station for various return period.

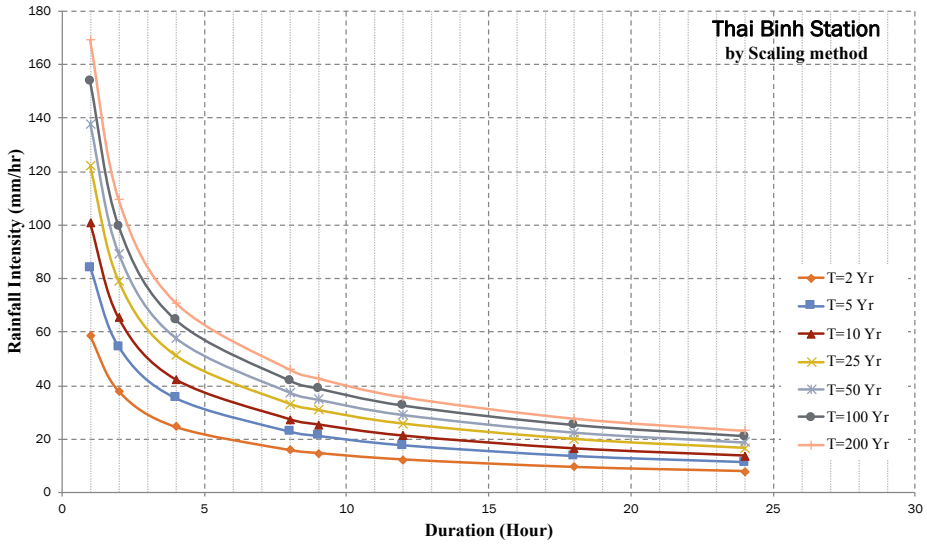


Fig. 15 IDF curves in Thai Binh Station for various return period.

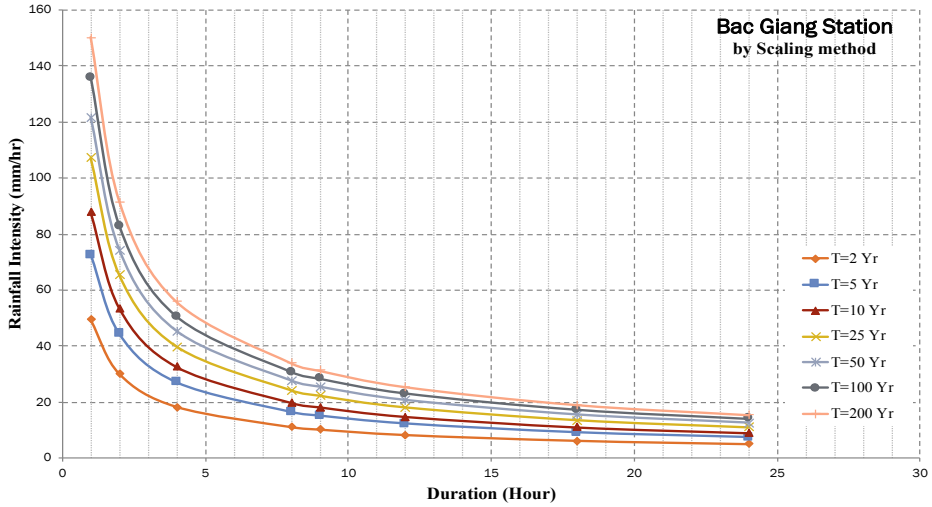


Fig. 16 IDF curves in Bac Giang Station for various return period.

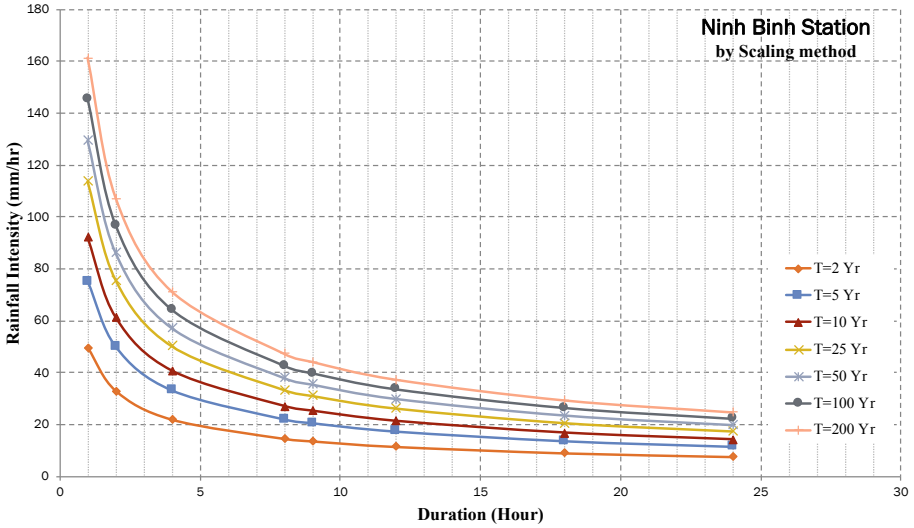


Fig. 17 IDF curves in Ninh Binh Station for various return period.

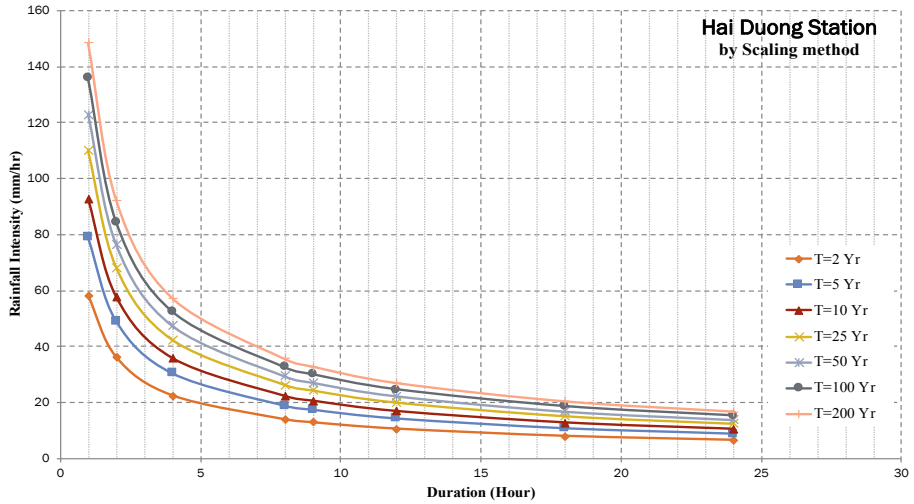


Fig. 18 IDF curves in Hai Duong Station for various return period.

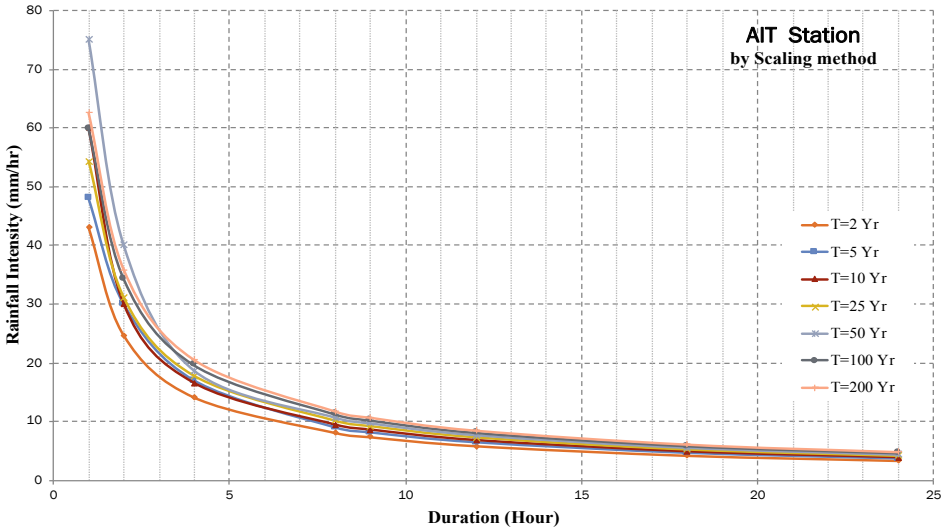


Fig. 19 IDF curves at AIT Station for various return period.

Kimijima Equation:

$$i_d = \frac{a}{d^e + b} \quad (7)$$

Where i is the rainfall intensity (mm/hr); d is the duration (minutes); a, b and e are the constant parameters related to the metrological conditions.

Frequency analysis techniques are used to develop the relationship between the rainfall intensity, storm duration, and return periods from rainfall data. Analysis of distribution for rainfall frequency is based on the Pearson Type III distribution, which is commonly used in Vietnam for this kind of analysis. The Pearson Type III distribution is written as Eq. (8):

$$f(x) = \frac{1}{|x|\Gamma(\lambda)}\left[\frac{x - x_0}{\alpha}\right]^{\lambda-1} \exp\left[-\frac{x - x_0}{\alpha}\right] \quad (8)$$

Where x_0 is the location parameter, α is the scale parameter, λ is the shape parameter. The Pearson Type III probability model is used to calculate the rainfall intensity at different rainfall durations and return periods to form the historical IDF curves for each station.

The Pearson Type III distribution used to calculate the rainfall intensity at different rainfall durations and return periods and the maximum rainfall intensity for consider durations and 2, 5, 10, 50, 100 and 200 years return periods, have been determined. The set of IDF curves can be estimated by Kimijima Equation in comparison with IDF constructed by scaling method.

The parameters of Kimijima equation are determined [6] presented in Table 7.

Table 7 The parameters of Kimijima equations as IDF curves.

Return periods T(years)	a	b	e
200	7084.931	28.843	0.754
100	5506.794	22.112	0.752
50	4553.066	18.121	0.762
20	3934.044	15.565	0.782
10	3410.582	13.471	0.821
5	3111.113	11.335	0.863
2	2349.924	9.810	0.851

In order to verify the new IDF curves, rainfall intensity calculated by empirical IDF equation is considered as observation rainfall intensity compared to rainfall intensity calculated by the new IDF curves. The result illustrated in Figs. 20-23.

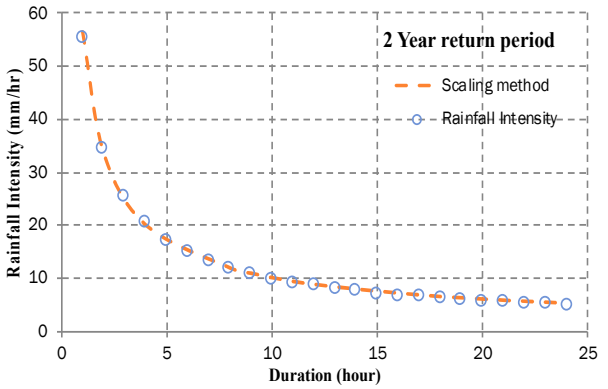


Fig. 20 Scaling method compared to traditional method (2 years return period).

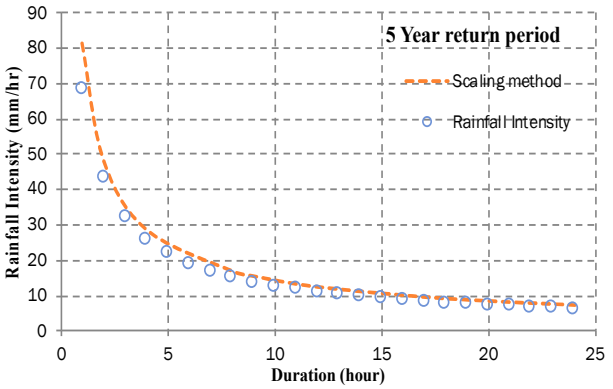


Fig. 21 Scaling method compared to traditional method (5 years return period).

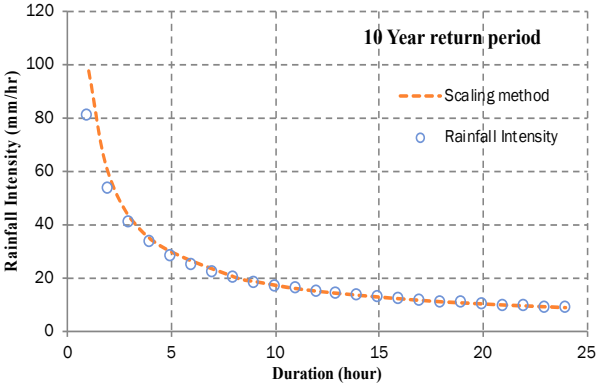


Fig. 22 Scaling method compared to traditional method (10 years return period).

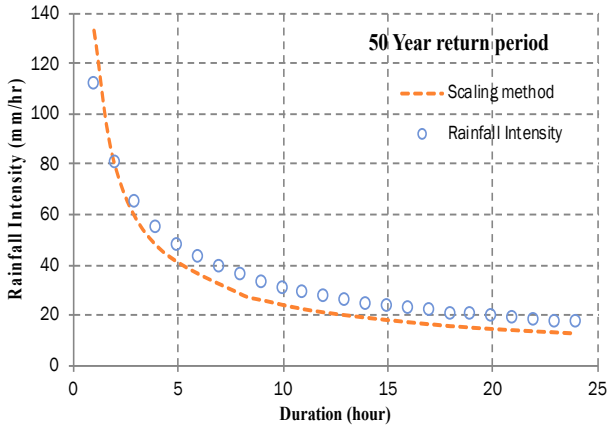


Fig. 23 Scaling method compared to traditional method (50 years return period).

4. Rainfall Design

Design storms act as inputs to urban drainage design hydrological models. There exist a variety of ways to define design storms. Some of them are based on a depth of precipitation at a point, on specification of time distribution of rainfall, or on isohyetal maps indicating regional spatial distribution of precipitation. Hyetographs can be constructed from local historical patterns of precipitation, or via synthetic methods able to capture rainfall features of a particular locality. An excellent background on this topic is given by Chow, V. T., et al. [10].

There are several design storm developed in various locations in the world to represent rainfall pattern. The design storm derived based on different assumptions therefore their shapes are different. Generally pattern of design storm can be considered in three parts.

The first part is the rising intensity started from beginning of storm to the peak. This part can be considered as:

One straight line such as Triangular Hyetograph Method;

Two straight lines such as Desbordes Storm Pattern;

Curve such as Chicago Hyetograph Method (Chicago Method).

The second part is the peaks which can be consider as:

One peak such as Triangular Hyetograph Method and Chicago Method;

Continuous peaks such as Sifalda Storm Pattern and Alternative Block Method.

The last part is decay intensity started from the peak to the end of storm. This part can be considered the same as the first part.

Statistical analysis of recorded rainfall data at Lang Station showed that the probability of occurrence of the annual maximum of subset of duration (0.5, 1, 3, 6 and 12 hours precipitation) in the same event is about 75% and the probability of occurrence of annual maximum of the remaining subset (24, 48, 72, 96 and 120 precipitation) in the same event is about 70%. This suggests that the existence of a sort of meteorological split of critical events for short and long durations.

Analysis of rainfall data at Lang Station shows that most extreme values of rainfall including hourly, daily occurrence in the storm with duration not less than 6 hours. Therefore, this study applied Chicago Hyetograph with considered storms has up to 6 hour duration and alternating block hyetograph method with rainfall of long low intensity (storm duration up to 24 hours and 48 hours).

Two other design hyetograph are considered: alternating block synthetic storm with the advancement peak coefficient r equal to 0.5, 24 hours duration and one modified alternating block storm with the mean advancement coefficient r equal to 0.153, 48 hours duration.

4.1 Rainfall Design Developed based on Scaling IDF Curves

4.1.1 Chicago Hyetograph Method

Chicago design storm developed from the relationship of intensity, duration and return period. The computed Chicago design storm for 6, 12, 24 hours duration are show in Figs. 24-26.

The Peak intensity of this design storm shows in Table 8. It can be seem that peak intensity increase

with return period but not change when storm duration increase.

4.2 Alternating Block Hyetographs

Alternating block and modified alternating block method had applied with time step of one hour, the two design hyetographs for Lang Station with 2 and 10 years return period derived based on scaling DDF curves at Lang Station were computed, as shown in Figs. 27 and 28.

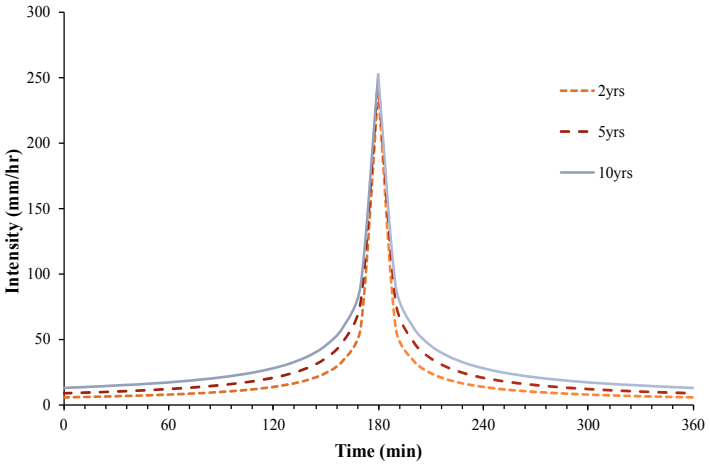


Fig. 24 Chicago design storm hyetographs for Lang Station with 6 hours duration.

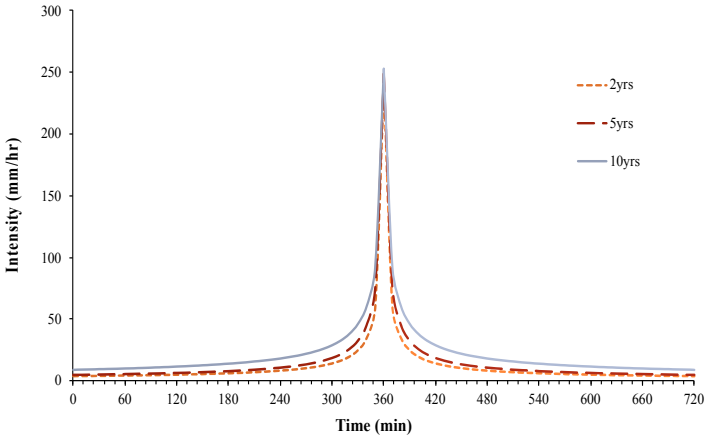


Fig. 25 Chicago design storm hyetographs for Lang Station with 12 hours duration.

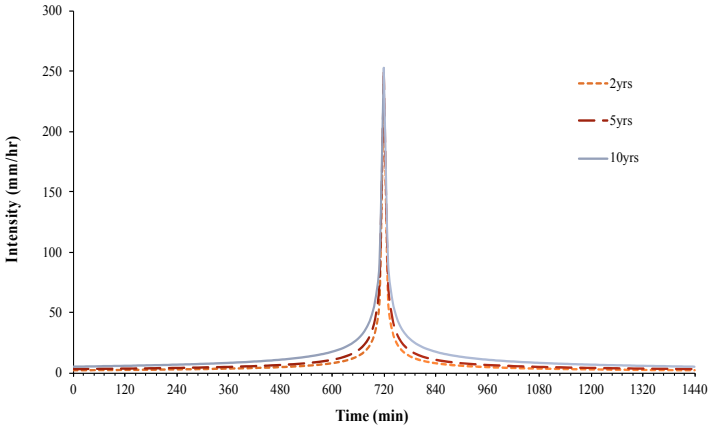


Fig. 26 Chicago design storm hyetographs for Lang Station with 24 hours duration.

Table 8 Peak intensity from Chigaco design storm based on annual maximum rainfall.

Return period (Year)	Peak intensity (6 hr)	Raifall depth (6 hr)	Peak intensity (12 hr)	Raifall depth (12 hr)
2	239.44	103.74	239.44	153.96
5	248.69	135.40	248.69	189.28
10	253.18	159.68	253.18	277.27

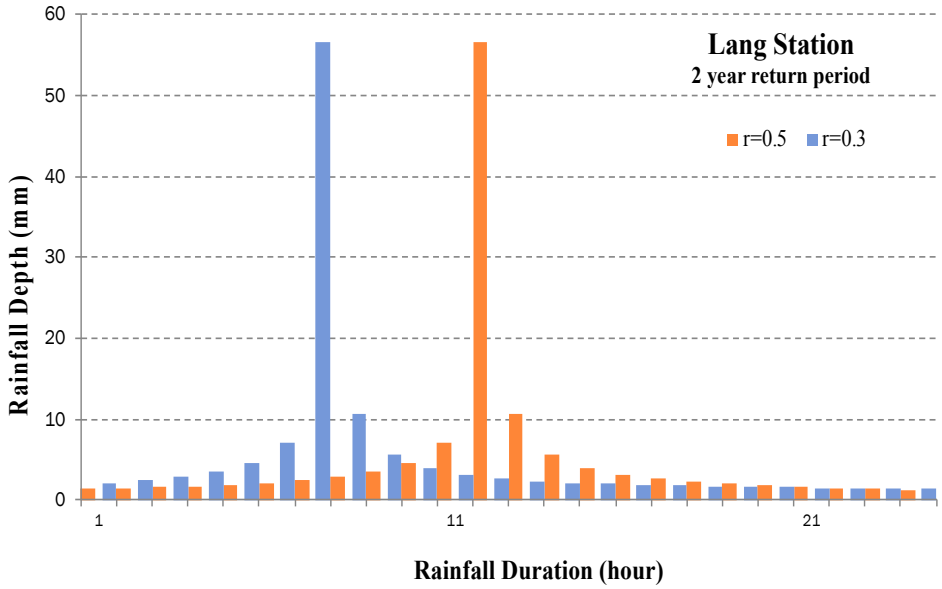


Fig. 27 24-hour design 2-years return hyetographs for Lang Station.

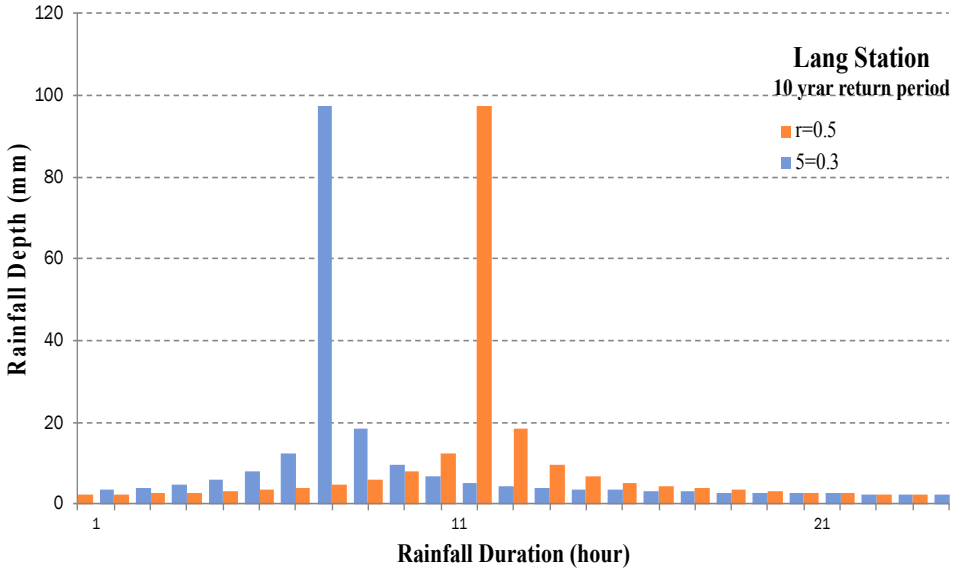


Fig. 28 24-hour design 10-years return hyetographs for Lang Station.

5. Conclusion and Recommendation

5.1 Rainfall Characteristics

The analysis of 1,508 storms in 1984, 1995, 1996, 2002 and 2008 showed that most of rainfall amount (approximately 70%) received from rains occurring between 6:0 pm to 6:0 am of the day after that. the daytime usually less rainfall occurrence with only 30%.

The peak rainfall is usually occurred during 0:0 am to 4:0 am having approximately 42.98% of rainfall amount over a day. The peak rainfall likely happen

earlier in the recent year (36% rainfall amount over a day occurrence from 6:00 pm to 10:00 pm in 2008).

The analysis also illustrated that approximately 40% of rainfall events have duration less than 60 minutes. In contrast, only approximately 9% of rainfall events have duration more than 6 hours but total rainfall depths of these events is approximately.

5.2 Intensity Duration Frequency Curves

The simple analytical formulation for rainfall IDF relationship has generalized IDF formulas from daily rainfall based on scaling properties of rainfall time series.

The IDF curves for short duration (sub-daily data) were derived from daily data. The simple scaling property verified by local data, the IDF relationship are deduced from daily rainfall which show good result as compared to IDF curves obtained from short-duration rainfall data.

The IDF curves for Monson climate areas in Vietnam has conducted and applied to Chicago hyetograph and Alternating Block methods.

The scaling properties of rainfall time series also shown good result when applied to conduct to the formulation and construction of IDF curves using data series recorded from AIT meteorological station. The comparison between IDF curves obtained by traditional method [16] show good result with rainfall duration from 60 minutes, with rainfall duration less than 60 minutes, scaling method provided rather high values.

References

[1] Sherman, C. W. 1931. "Frequency and Intensity of Excessive Rainfalls at Boston, Massachusetts." *Transactions ACSE* 95: 951-960.

[2] Bernard, M. M. 1932. "Formulas for Rainfall Intensities of Long Durations." *Transactions ASCE* 96: 592-624.

[3] Watt, W. E., Chow, K. C. A., Hogg, W. D., and Lathem, K. W. 1986. "A 1-hour Urban Design Storm for Canada." *Canadian Journal of Civil Engineering* 13 (3): 293-300.

[4] Burlando, P., and Rosso, R. 1996. "Scaling and Multiscaling Models of Depth-urationfrequency Curves for Storm Precipitation." *Journal of Hydrology* 187: 45-64.

[5] Menabde, M., Seed, A., and Pegram, G. 1999. "A Simple Scaling Model for Extreme Rainfall." *Water Resources Research* 35: 335-339.

[6] Nhat, L. M., Tachikawa, Y. and Takara, K. 2006. "Establishment of Intensity-Duration-Frequency Curves for Precipitaion in the Monsoon Area of Vietnam." *Annuals of Disas. Prve. Rec. Inst., Kyoto Univ., No.* 49B, 93-102.

[7] Rodriguez-Iturbe, I., Gupta, V. K., and Waymire, E. 1984. "Scale Considerations in the Modeling of Temporal Rainfall." *Water Resources Research* 11 (20): 1611-1619.

[8] Koutsoyiannis, D., Kozonis, D., and Manetas, A. 1998. "A Mathematical Framework for Studying Intensity-duration-frequency Relationships." *Journal of Hydrology* 206: 118-135.

[9] Gupta, V. K., and Waymire, E. 1990. "Multiscaling Properties of Spatial Rainfall and River Flow Distributions." *Journal of Geophysical Research* 95 (D3): 1999-2009.

[10] Chow, V. T., David, R. M, and Larry, W. M. Eds. 1988. "Applied Hydrology." *Water Resources and Environmental Engineering.* Singapore. Mc Graw Hill.

[11] Keifer, C. J., and Chu, H. H. 1957. "Synthetic Storm Pattern for Drainage Design." *Journal of the Hydraulic Division. ASCE* 83 (HY4): 1332/1-1332/24.

[12] Sifalda, V. 1973. "Entwicklung eines Berechnungsregens fur die Bemessung von Kanalnetzen." *Gwf-wasser/abwasser* 144 (H9): 435-440. (In Germany Languages)

[13] Yen, B. C., and Chow, V. T. 1980. "Design Hyetographs for Small Drainage Structures." *Journal of the Hydraulics Division ASCE* 106 (HY6): 1055-1076.

[14] Huff, F. A. 1967. "Time Distribution of Rainfall in Heavy Storms." *Water Resources Research* 3 (4): 1007-1019.

[15] Nguyen, V. T. V. and Pandey G. R. 1994. "Estimation of Short-duration Rainfall Distribution using Data Measured at Longer Time Scales." *Water Science and Technology* 29 (1- 2): 39-45.

[16] Wiwat, C. 2006. *Analysis of Rainfall Pattern for Urban Drainage Design.* (Master thesis No. WM-05-1, Asian Institute of Technology, 2006). Bangkok: Asian Institute of Technology.

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Recovery of Copper and Cobalt from Converter Slag with a New Flotation Method Using H_2S

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Abstract: In this study, two different samples were obtained from Küre Copper factory. It was determined that the samples contain: the sample of K.C.F. (Küre Copper Factory), 0.70% Cu and 0.5% Co. This sample was firstly grounded at -100 mesh dimension. Flotation was done according to previously obtained optimum flotation conditions. The flotation yield of Cu and Co in concentrate phase was found to be low by collective flotation. Even when the samples were grounded at -160 mesh, no change was observed in the flotation result. Especially, Co could not float under the flotation conditions of the non-sulfurized samples. There, a new flotation method was applied which was not applied until now. For this aim, the samples were firstly sulphurised under the steam of $H_2S + H_2O$. By this method, the amount of Cu and Co in the samples get rich. According to the obtained results, the optimum reactions for flotation and sulphurization were determined. In the first sulphurization conditions for the sample of K.C.F., the yield of flotation for the Co and Co were found to be 98.27% and 68.07%, respectively. The results indicate that Cu can be floated at low yield in the original samples. On the other hand, Co cannot float under these conditions.

Key words: Converter slag, flotation, copper, cobalt, sulphurization.

1. Introduction

Copper slag is produced in large amounts in seven copper smelter plants in Chile, and it is estimated that around 4 million tons of slag are disposed every year and another 40 to 45 million tons are historically cumulated [1]. Different slags need aid transformed as by-products clinched alongside metallurgical methods alternately as residues on incineration methods. As stated by the sources and the characteristics, those fundamental slags might be ordered under three categories, in particular, ferrous slag, non-ferrous slag furthermore incineration slag. Slags generally hold numerous amount of profitable metals. They would really be an auxiliary asset from claiming metals, instead of an end-waste, what's more, they would be connected as an asset material in numerous zones. Clinched alongside addition, to a portion application, slags bring tantamount alternately indeed better properties over their focused materials. The third characteristic may be that some slags hold an outstanding amount of hurtful alternately overwhelming metals. Those discharge about these metals might cause natural issues [2, 3].

Metallurgical strategies would as a rule used to treat ores, what's more, of the enriching procedure by flotation strategies, are attractive division. A past article accounted that floatation what's more, attractive detachment methods, utilizing slag, didn't bring about acceptable extractions starting with converter slag [4].

Much exploration needs to be been conveyed out on the recuperation of copper from slags. Suggested strategies for cleaning the slag are flotation [5, 6], leaching, electric heater and so on [7].

Copper smelting techniques may be used [5, 8-11]. There are also some hydrometallurgical methods given in the literature for the treatment of slags, such as leaching in nitrate, perchloride, chlorate and

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sulfuric acids [12, 13] with and without pressure [13], ferric chloride [8, 14, 15], ferric sulfate [7], cyanide, thiosulphate leaching [16], ferric sulfate and ammonia sulfate solutions [7, 12, 17, 18].

In this study, the flotation of converter slag was attempted. When this was unsuccessful, a sulfurization process developed in the previous studies was used. As a result of this process, a new surface forms on the converter slag particles and flotation experiments were carried out using these samples [19-21]. As seen in the previous studies, successful results cannot be obtained by direct flotation of the original converter slag. However, in this study, significant results were obtained by flotation of a sample obtained from an appropriate sulfurization process.

2. Experimental

2.1 Reagents and Instrumentation

In this study, the converter slag used was supplied from the Kastamonu-Küre, Turkey. Küre is in the Western Black Sea region of Turkey, are a leading copper and pyrite ore production area. Analyses show that the ore obtained from the Küre Region contains 0.70% copper, 0.50% cobalt and 21.98% sulfur. The K-Amyl xanthate and Dowfroth 250 used in flotation were taken from the Ergani Copper Mining Co in Turkey. The chemicals used in these studies such as 96% (w/v) H_2SO_4, 37% (w/v) HCl, 65% (w/v) HNO_3, FeS and $KClO_3$ were purchased from Merck. The sample crushing was broken in a crusher belonging to Unal Engineering as -100 mesh size. The experiments were conducted in a laboratory equipped with facilities for carrying out hydrometallurgical operations such as autoclave leaching. Denver mark flotation apparatus and Nel 890 Model pH meter were used for flotation and determination of pH of samples, respectively. Sulfur in various forms was oxidized to sulfate form and precipitated as $BaSO_4$ and the precipitate with fixed weighing was analyzed by gravimetric method [22]. The compositions of all samples were determined using a Unicam 929 Model AAS. The spectral wavelength selected for the metal analyses is shown in Table 1.

In this study, the solutions used were prepared with concentrations of 25-100 ppm for copper and 20-60 ppm for cobalt. Calculation of flotation yield was made according to Eq. (1).

$$\text{F.Y.\%} = \frac{\text{Amount of substance required to float in Floating Substance}}{\text{The total amount of substance required to floate within the substance used in the flotation}} \times 100 \quad (1)$$

2.2 Method

The converter slag sample was first crushed and then ground to -100 mesh sizes, sieved and dried at 110 °C. These samples were used in chemical analyses and flotation studies. H_2S was produced by addition of H_2SO_4 to FeS [6, 21] obtained from pyrite. The sulfurization process was performed in an autoclave of 1.3-liter internal volume, with 60 minutes residence time at 100 °C. Different ratios of a gas mixture of $H_2S + H_2O$ were performed. Then, samples obtained from autoclave were floated by using potassium amyl xanthate and Dowfroth 250. After the obtained concentrates and wastes are solubilized with acid, analyzes are read in AAS.

3. Results and Discussion

3.1 Effect of pH on the Flotation of Converter Slag

Converter slag sample was floated at different pHs and the results are given in Fig. 1 [21].

This study was carried out under the conditions indicated in Table 2.

As seen in Fig. 1, the best flotation yield was at pH 11.0.

For flotation, 100 g of the ore sample was fed and 28.56 g of converter slag was floated. The flotation yields of Cu and Co were determined as 57.81% and

Table 1 The spectral wavelength of metal for AAS.

Metal	Wavelength (nm)	Silit (nm)	Current (mA)	Oxidant-Fuel
Copper	324.75	0.5	3	Air-Acetylene
Cobalt	240.73	0.2	10	Air-Acetylene

Table 2 Flotation condition at different pHs.

Parameter	Flotation condition
Particle dimension	-100 mesh
Solid/liquid ratio	100 g/L
Collector	0.2 g Z_5 (KAX) 3 minute mix
Frother	0.5 mL Dowfroth 250 (1%) 2 minute mix
Mix speed	900 periods/minute
Flotation time	3 minute

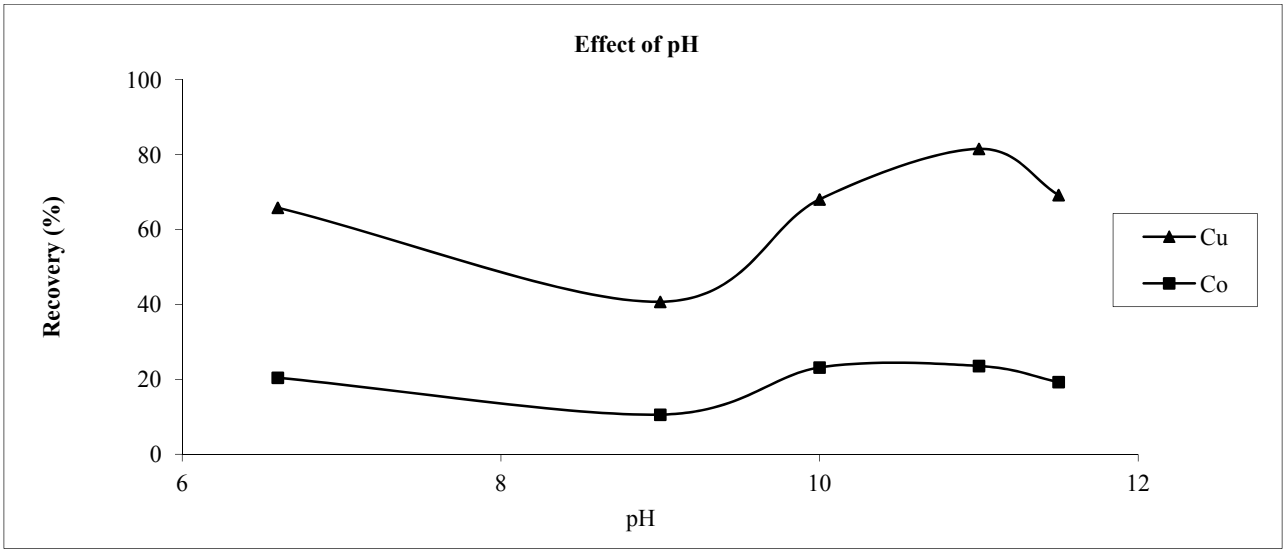

Fig. 1 The effect of pH on the flotation yield.

34.38% respectively, and their concentrate grades of Cu and Co have ascertained as 1.17% and 0.43% Co. At the end of the flotation process, the results aimed were not attained, and flotation yield was low. Converter slag samples were first sulfurized at 100 °C by using various ratios of H_2S + H_2O. Then, these samples were floated.

3.2 The Flotation of Sulfurized Converter Slag

Firstly, the converter slag samples were ground, sieved to -100 mesh size, dried at 110 °C and then reacted with gas mixtures containing different amounts of H_2S + H_2O for 1 hour at 100 °C. For this purpose, the six samples each of which was 1000 g, were reacted with mixtures of H_2S and H_2O separately as seen in Table 3.

After sulfurization, the sulfurized samples were floated at pH 11 under the conditions indicated in Table 2.

Eight sulfurized sample was floated at different sulfurization condition and the results are given in Fig. 2 and Table 4.

As seen in Table 4, the best result was obtained from a seventh sulfurized sample by flotation. In order to be understood better these results; they are given in Fig. 2 with respect to different H_2S values.

3.3 The Effect of the Activator

In this step, the flotation process on the seventh sulfurized sample was performed to test the effect of

Table 3 The used amount of gas mixtures of H_2S and H_2O.

Sulphurization number	H_2S amount (g)	Water amount (g)
1	3.83	20
2	5.74	30
3	7.66	40
4	9.57	50
5	13.40	70
6	15.32	80
7	17.23	90
8	19.14	100

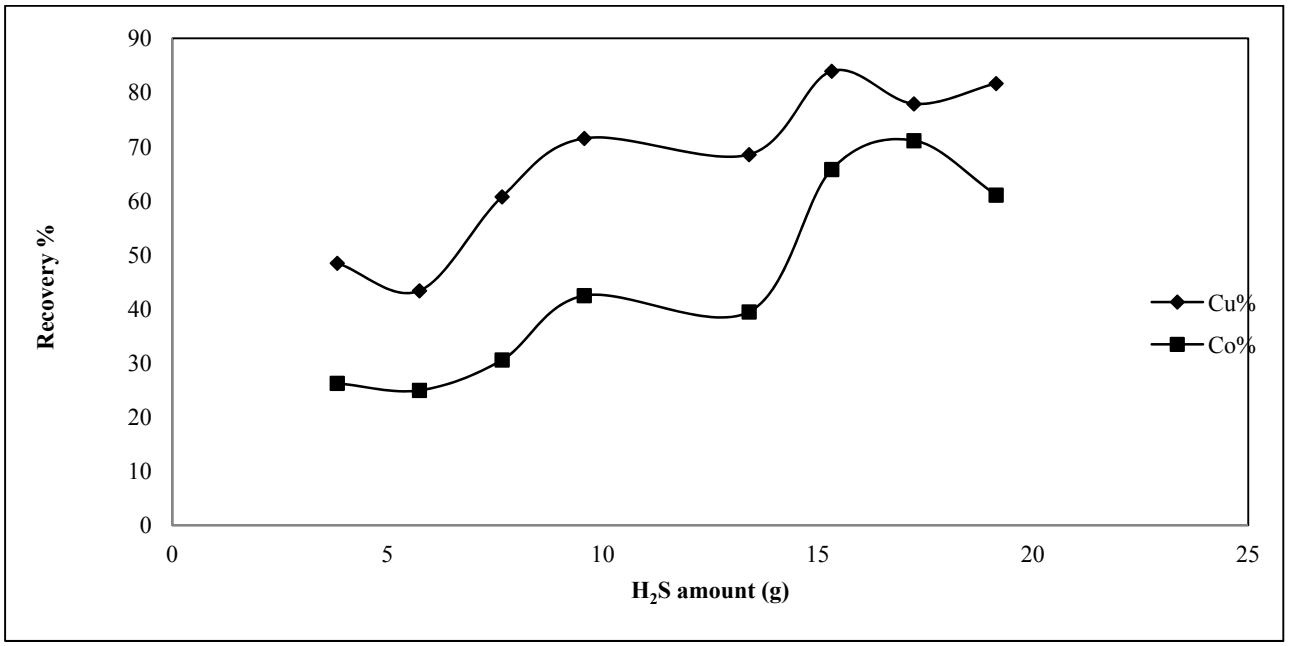

Fig. 2 The effect of sulfurization on the flotation yield of sulfurized samples (at pH 11).

Table 4 The values obtained by flotation of the sulfurized sample.

Sulphurization number		1	2	3	4	5	6	7	8
pH		11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
Froth (g)		22.28	23.93	26.70	40.51	37.05	62.67	47.86	61.23
Tailing (g)		76.03	76.13	72.70	59.40	62.32	37.07	51.96	38.18
Recovery (%)	Cu%	48.45	43.36	60.72	71.51	68.52	83.93	77.89	81.66
	Co%	26.26	24.96	30.57	42.46	39.46	65.78	71.10	61.05
Concentrate Assay (%)	Cu%	1.31	1.25	1.68	1.37	1.42	0.86	1.38	0.70
	Co%	0.45	0.42	0.67	0.64	0.66	0.44	0.74	0.43
Unfloated Assay (%)	Cu%	0.43	0.43	0.40	0.37	0.38	0.24	0.36	0.25
	Co%	0.38	0.40	0.57	0.58	0.59	0.39	0.28	0.23
Time (Min)		2.50	3.20	4.40	4.30	5.00	3.00	2.07	2.30

activator amount. The studies were carried out at pH 11.0 and by using 10 mg, 30 mg, 50 mg, 60 mg, 80 mg, 125 mg, 150 mg and 200 mg $CuSO_4$ and results are given in Fig. 3.

Flotation studies were conducted using $CuSO_4$, it can be seen that there is not a significant difference in flotation yield as activator and depressant changes. Thus, the results were not given.

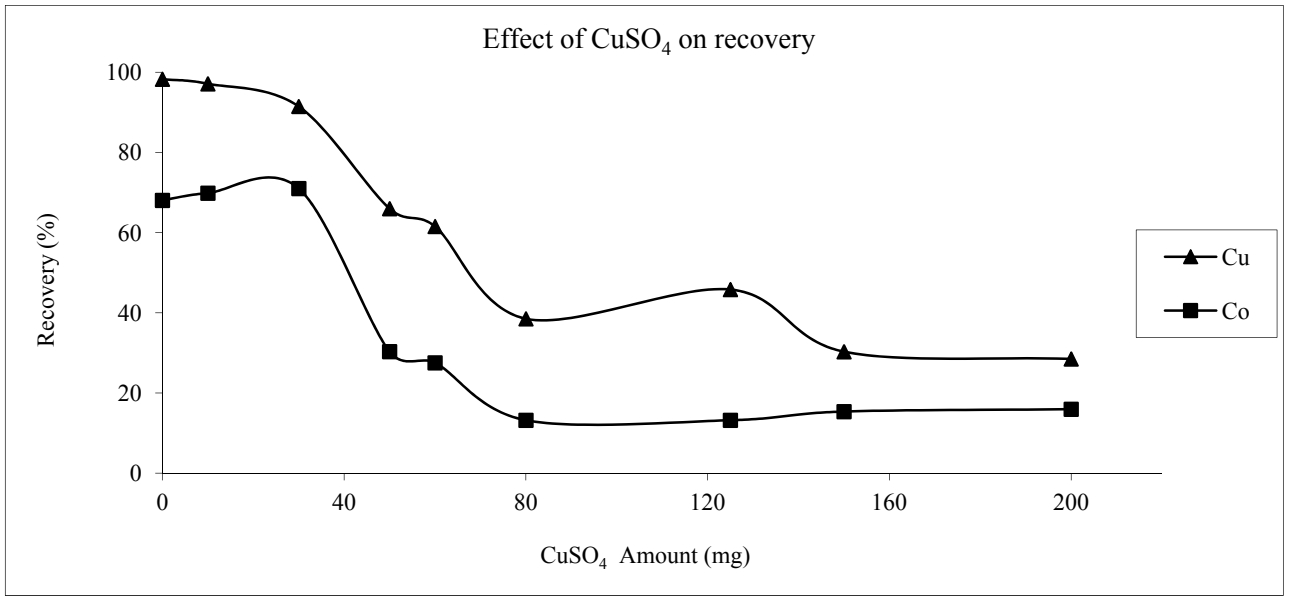

Fig. 3 The effect of activator amount on the floatability of the result obtained from seventh sulfurized samples.

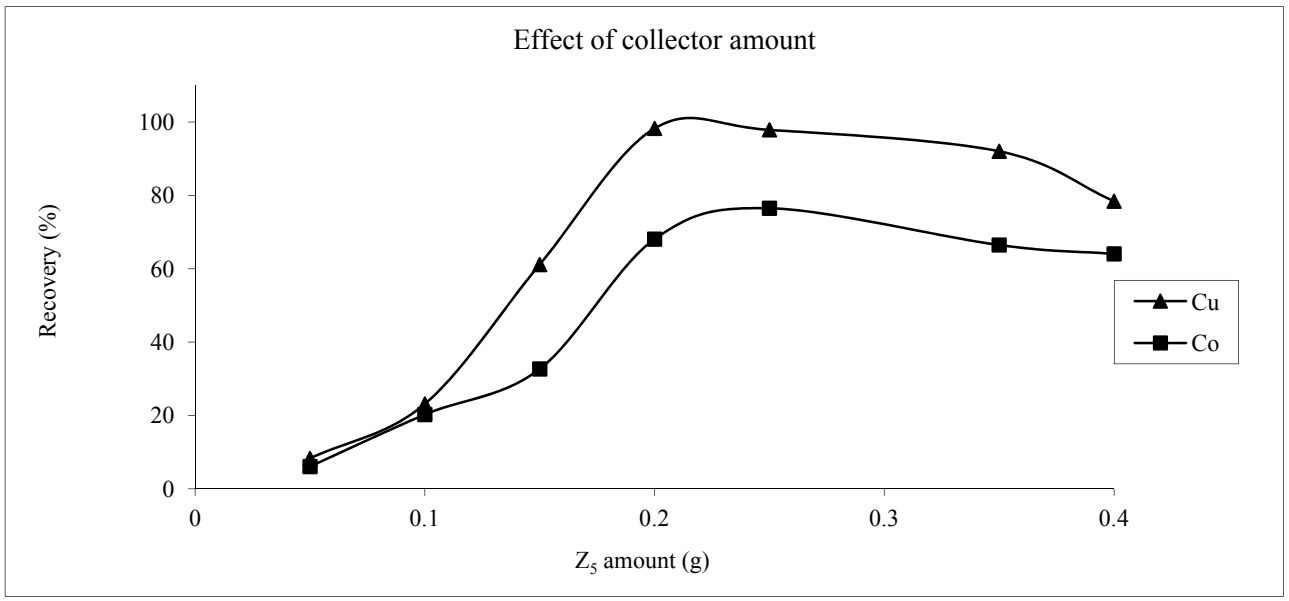

Fig. 4 The effect of collector amount on the floatability of the result obtained from a seventh sulfurized sample.

3.4 The Effect of Collector Amount

In this step, the flotation process on the seventh sulfurized sample was performed to test the effect of collector amount. The studies were carried out at pH 11.0 and by using 0.20 g, 0.25 g, 0.30 g and 0.35 g KAX (K-amyl Xanthate) and results are given in Fig. 4.

4. Conclusions

The findings of this study are as:

- Enrichment cannot be achieved with the flotation of original ore;
- For enrichment with flotation, it was understood that a new surface is required;
- It was determined that the efficiency increased with the flotation of the sample obtained from sulfurization of converter slag samples, sized to -100 mesh with the appropriate amount of H_2S. e.g. For sulfurization of one kg of sieved ore, 17.23 g H_2S +

90.00 g H_2O gas mixture is enough. The sulfurization was finished in 1 hour in the autoclave for 100 °C;

- When the flotation of converter slag is performed at pH 11.00, maximum efficiency of copper and cobalt was obtained;
- Increase in the efficiency in the flotation of sulfurized samples is not only limited to the converter slag; the amount of H_2S used according to the composition of copper ore must be determined experimentally.

References

[1] Busolic, D., Parada, F., Parra, R., Sanchez, M., Palacios, J., and Hino, M. 2011. "Recovery of Iron from Copper Flash Smelting Slags." *Mineral Processing and Extractive Metallurgy* 120 (1): 32-6. doi: 10.1179/037195510X12772935654945.

[2] Shen, H., and Forssberg, E. 2003. "An Overview of Recovery of Metals from Slags." *Waste Management* 23 (10): 933-49. doi: 10.1016/S0956-053X(02)00164-2.

[3] Bellemans, I., De Wilde, E., Moelans, N., and Verbeken, K. 2017. "Metal Losses in Pyrometallurgical Operations—A Review." In *Advances in Colloid and Interface Science*. Elsevier. doi: 10.1016/J.CIS.2017.08.001.

[4] Yuksel, U., Tegin, I., and Ziyadanogullari, R. 2017. "Recovery of Copper and Cobalt from Copper Slags as Selective." *Journal of Environmental Science and Engineering A* 6 (8): 388-94. doi: 10.17265/2162-5298/2017.08.002.

[5] Sarrafi, A., Rahmati, B., Hassani, H. R., and Shirazi, H. H. A. 2004. "Recovery of Copper from Reverberatory Furnace Slag by Flotation." *Minerals Engineering* 17 (3): 457-9. doi: 10.1016/j.mineng.2003.10.018.

[6] Tegin, I., and Ziyadanugullari, R. 2008. "The Effect of Sulfurization Process on Flotation of Copper Ore Containing Gold and Silver." *Journal of Minerals and Materials Characterization and Engineering* 7 (3): 193-202. doi: 10.4236/jmmce.2008.73015.

[7] Altundoğan, H. S., and Tümen, F. 1997. "Metal Recovery from Copper Converter Slag by Roasting with Ferric Sulphate." *Hydrometallurgy* 44 (1-2): 261-7. doi: 10.1016/S0304-386X(96)00038-2.

[8] Anand, S., Rao, P. K., and Jena, P. K. 1980. "Recovery of Metal Values from Copper Converter and Smelter Slags by Ferric Chloride Leaching." *Hydrometallurgy* 5 (4): 355-65. doi: 10.1016/0304-386X(80)90025-0.

[9] Muravyov, M. I., Fomchenko, N. V., Usoltsev, A. V., Vasilyev, E. A., and Kondrat'eva, T. F. 2012. "Leaching of Copper and Zinc from Copper Converter Slag Flotation Tailings Using H_2SO_4 and Biologically Generated $Fe_2(SO_4)_3$." *Hydrometallurgy* 119-(1): 40-6. doi: 10.1016/j.hydromet.2012.03.001.

[10] Filippou, D., St-Germain, P., and Grammatikopoulos, T. 2007. "Recovery of Metal Values From Copper—Arsenic Minerals and Other Related Resources." *Mineral Processing and Extractive Metallurgy Review* 28 (4): 247-98. doi: 10.1080/08827500601013009.

[11] Ferron, C. J., and De Cuyper, J. 1992. "The Recovery of Copper and Zinc from a Sulphide Concentrate Using Sulphate Roasting, Acid Leaching and Solution Purification." *International Journal of Mineral Processing* 35 (3-4): 225-38. doi: 10.1016/0301-7516(92)90035-U.

[12] Sukla, L. B. B., Panda, S. C. C., and Jena, P. K. K. 1986. "Recovery of Cobalt, Nickel and Copper from Converter Slag through Roasting with Ammonium Sulphate and Sulphuric Acid." *Hydrometallurgy* 16 (2): 153-65. doi: 10.1016/0304-386X(86)90040-X.

[13] Anand, S., Rao, K. S., and Jena, P. K. 1983. "Pressure Leaching of Copper Converter Slag Using Dilute Sulphuric Acid for the Extraction of Cobalt, Nickel and Copper Values." *Hydrometallurgy* 10 (3): 305-12. doi: 10.1016/0304-386X(83)90061-0.

[14] Ziyadanoğullari, B. 2000. "Recovery of Copper and Cobalt from Concentrate and Converter Slag." *Separation Science and Technology* 35 (12): 1963-71.

[15] Herreros, O., Quiroz, R., Manzano, E., Bou, C., and Vinals, J. 1998. "Copper Extraction from Reverberatory and Flash Furnace Slags by Chlorine Leaching." *Hydrometallurgy* 49 (1): 87-101. doi: 10.1016/S0304-386X(98)00010-3.

[16] Ficeriova, J., Balaz, P., and Boldizrova, E. 2005. "Combined Mechanochemical and Thiosulphate Leaching of Silver from a Complex Sulphide Concentrate." *International Journal of Mineral Processing* 76 (4): 260-5. doi: 10.1016/j.minpro.2005.01.005.

[17] Burzyńska, L., Gumowska, W., Rudnik, E., and Partyka, J. 2008. "Mechanism of the Anodic Dissolution of Cu70-Co4-Fe14-Pb7 Alloy Originated from Reduced Copper Converter Slag in an Ammoniacal Solution. Recovery of Copper and Cobalt." *Hydrometallurgy* 92 (1-2): 34-41. doi: 10.1016/j.hydromet.2008.01.009.

[18] Tümen, F., and Bailey, N. T. 1990. "Recovery of Metal Values from Copper Smelter Slags by Roasting with Pyrite." *Hydrometallurgy* 25 (3): 317-28. doi: 10.1016/0304-386X(90)90047-6.

[19] Aydın, F. 2002. *Investigation of Ways to Evaluate Oxidized Copper Ore and Pyridine.* Dicle University Institute of Science.

[20] Aydın, I. 2001. *New Practices in the Acquisition of Uranium, Nickel, Molybdenum and Vanadium from the Southeastern Asphaltite Ash*. Dicle University Institute of Science.

[21] Teğin, İ. 2002. *Recovery of Copper and Cobalt from Converter Slag with Flotation*. Dicle University Institute of Science.

[22] Jeffery, G. H., Bassett, J., Mendham, J., and Denney, R C. 1989. *Vogel's Textbook of Quantitative Chemical Analysis, Fifth edit*. New York: Longman Scientific & Technical with John Wiley & Sons, Inc.. doi: 10.1085/jgp.25.4.523.

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Temporal and Spatial Variation of Benthic Intertidal Community of a Sandstone Reef in Pernambuco—Brazil as a Tool to Evaluate Bioinvasion

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Abstract: In this study, the superior and inferior intertidal areas of hard substrate were sampled during the rainy season (June and August) and dry season (October and December) of 2015 at Piedade Beach. The percent cover of *Chthamalus bisinuatus*, *Brachidontes solisianus*, *Isognomon bicolor*, *Ulva* spp. and filamentous green algae were measured with a 20 × 20 cm quadrat with one hundred intersections. The quadrats were placed randomly at the sampling sites of Piedade reef. One-way ANOVAs (Analyses of Variance) were used to test the temporal variation of the studied organisms. *Chthamalus bisinuatus* occurred only in the superior mesolitoral where they had an increase in percent cover during the dry season, which wasn't statistically significant. *Brachidontes solisianus* occurred in both superior and inferior levels and had a significant decrease in the superior intertidal during the dry season. *Isognomon bicolor* occurred only in the inferior level and decreased to almost zero in the December. *Ulva* spp. and green filamentous algae had an opposite pattern in the inferior intertidal although only the filamentous algae showed a significant decrease in the dry season. Organisms such as *Chthamalus bisinuatus* resists better the heat and are dominant in the superior intertidal levels of reefs and rocky coasts. *Brachidontes solisianus* didn't change much in the lower intertidal and showed that can coexist with the invasive *Isognomon bicolor*. While the filamentous green showed a decrease in the dry season probably more affected by desiccation than *Ulva* spp. at Piedade reef.

Key words: Bioinvasion, community ecology, sandstone reefs, *Isognomon bicolor*.

1. Introduction

The coastal reefs of the urban Pernambuco regions suffer with algal overgrowth that in intertidal regions compete mainly with mollusks and crustaceans. These algae grow attached to the substrate or as drift in reef pools [1-3]. The increase in biomass and cover of substrate is related to the increment in nutrients and available light after the rainy season, with predictable nutrient accumulation in the algal thallus. Algae, specially the perennial, are affected by the waves action, which cause algal drift on the coast that can happen also with the filamentous green algae [3]. The sedimentation and species' invasion are other harmful factors that affect the reefs. The invasive bivalve *Isognomon bicolor* comes from the Caribbean sea and could have been introduced in the Brazilian coast by ballast water or ship biofouling [4, 5]. Its occurrence extends from the northeast to south coast of Brazil [6]. This organism settles mainly in the intertidal zone and competes with the bivalve *Brachidontes* and cirripedia such as *Tetraclita* [7]. Studies on intertidal indicate that the biotic factors, as competition for space and predation, more strongly affect the lower limit of the organisms, and the physical factors affect more in the upper limit [8, 9]. *Chthamalus* were observed as competitive superior after substrate cleaning and desiccation in relation to *Brachidontes* on the Piedade reefs [2, 10]. While green algae were found with greater biomass in the months just after the rainy season [11]. *Isognomon bicolor* also had a greater

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density during the rainy season showing that desiccation can maintain bivalves and specially barnacles showing a resistence to bioinvasion during the dry season [2, 5]. Predation by *Stramonita haemastoma* can be preferential over the native organisms *Chthamalus* and *Brachidontes*. The occurrence of cirripedia and *Brachidontes* in the superior and inferior intertidal show that spatial variation can also help coexistence of bioinvasion in addition to seasonality. In this study, percent cover of *Chthamalus bisinuatus*, *Brachidontes solisianus*, *Isognomon bicolor*, *Ulva* spp. and filamentous green algae were measured with the objective of evaluate the spatial variation of these species on the intertidal in dry and rainy periods to demonstrate the possibility of coexistence and resistence to bioinvasion.

2. Materials and Methods

Piedade Beach is located in Jaboatão dos Guararapes district, in the southern littoral of Pernambuco state, between 08º11'08.48'' S and 34º55'04.66'' W-08º11'03.45'' S and 34º55'03.24'' W. The reef is oriented obliquely in relation to the littoral and is covered by water during high tides [1]. The local climate is characteristic of the Tropical Atlantic, with an average air temperature of 26 ^{o}C. The annual pattern of rainfall defines two seasons: the dry season (from October through February) and the rainy season (from March through September). Three random 20 × 20 cm quadrats with one hundred intersections were sampled on the upper and lower mesolitoral to evaluate percent cover of dominant algae and benthic invertebrate in the months of June, August (rainy season) and October and December (dry season) of 2015. One-way ANOVAs and Tukey tests were made after square root transforming the data to confirm seasonal variation of the dominant reef biota.

3. Results

Chthamalus bisinuatus was more abundant on upper intertidal than in the lower intertidal. This species was significant more abundant on dry season but not statistically (Fig. 1).

Brachidontes solisianus occurred in both superior and inferior levels and had a significant decrease in the superior intertidal during the dry season ($p < 0.05$) whereas percent cover did not show significant variability in the inferior level ($p > 0.05$).

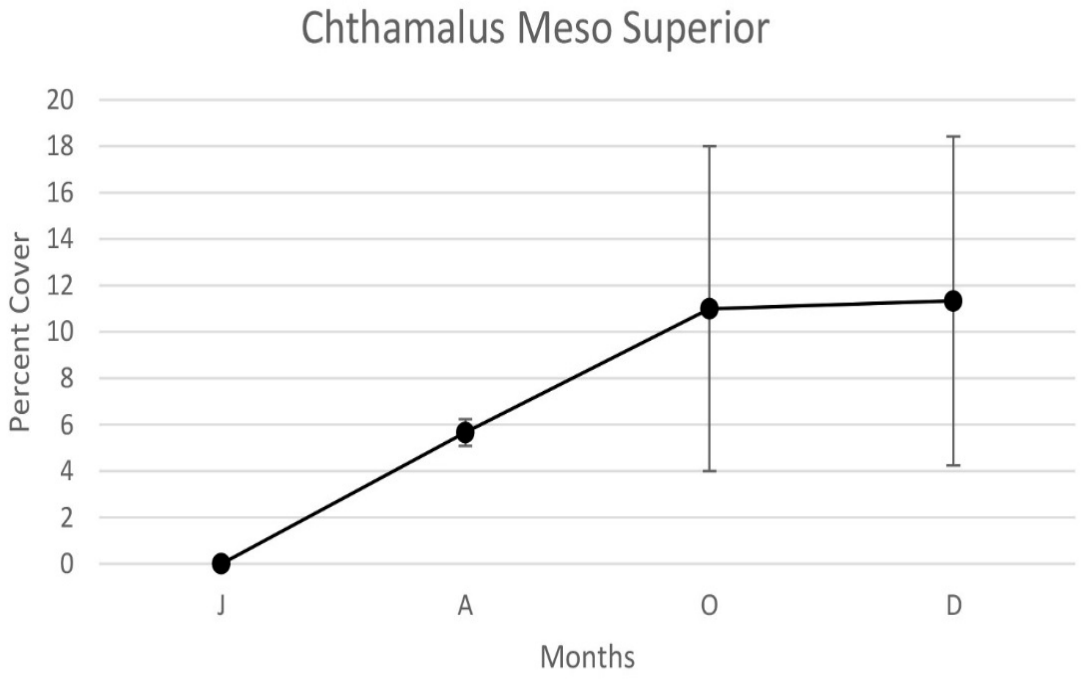

Fig. 1 Temporal variation of *Chthamalus bisinuatus* at Piedade reef.

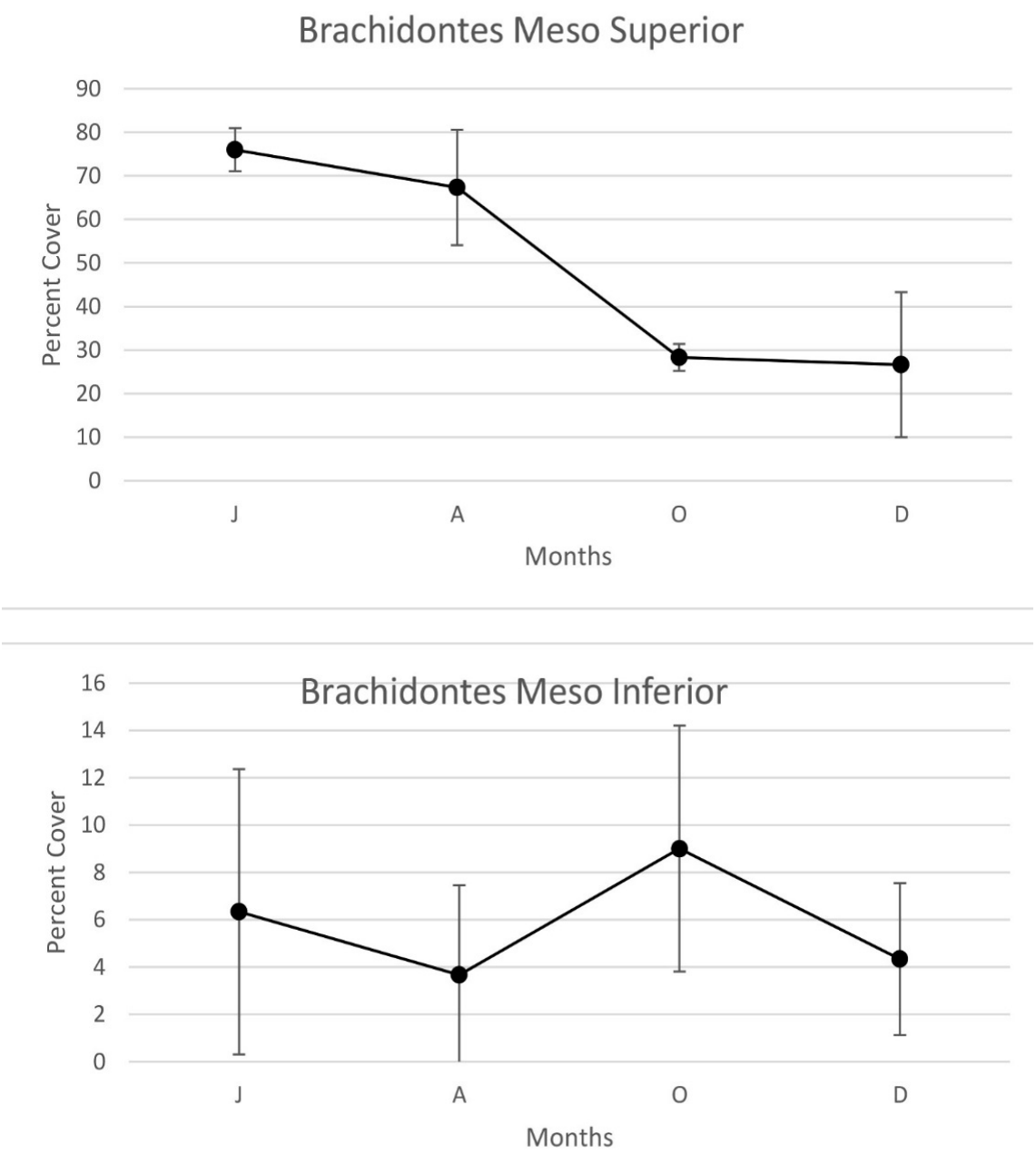

Fig. 2 Temporal variation of *Brachidontes solisianus* at Piedade reef.

For *B. solisianus*, percent cover in both months June and August were significantly different than October and December confirming the decrease during the dry season (Fig. 2).

Isognomon bicolor occurred only in the inferior level and decreased to almost zero in the December ($p < 0.05$) which was different from the other 3 sampling months (Fig. 3).

Ulva spp. and green filamentous algae had an opposite pattern in the inferior mesointertidal (Fig. 4), although only the filamentous algae showed a significant decrease in the dry season ($p < 0.05$) they can be influenced by pollution and grow just after the rainy season in urbanized areas [11, 13].

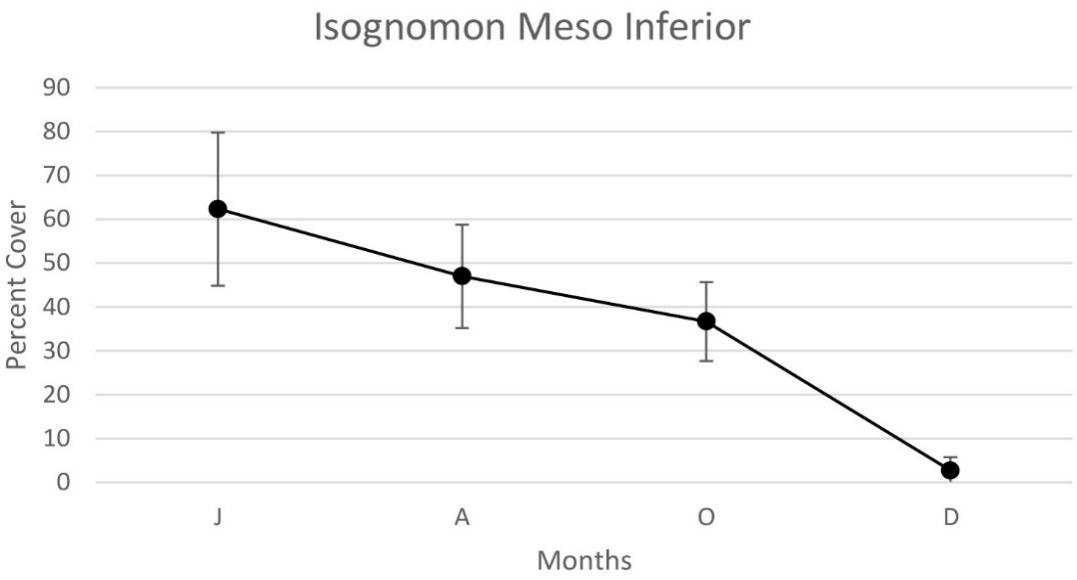

Fig. 3 Temporal variation of *Isognomon bicolor* at Piedade reef.

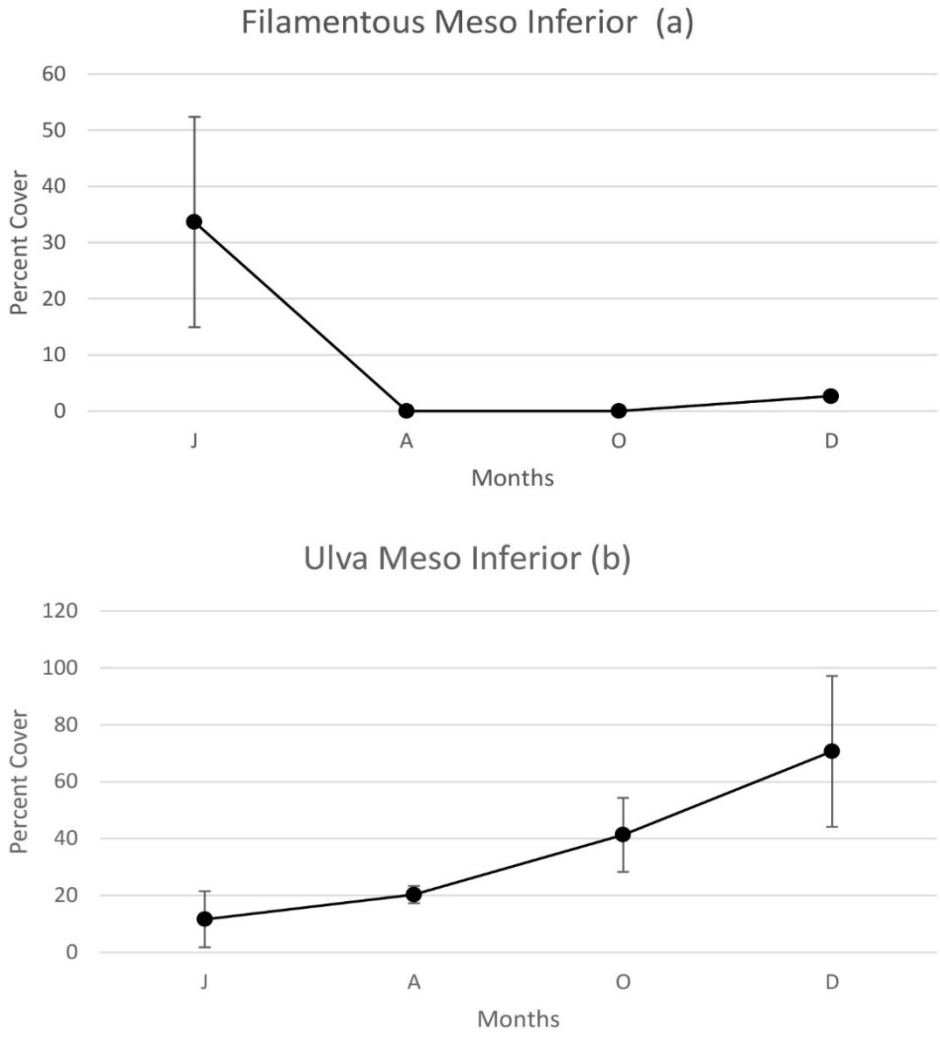

Fig. 4 Temporal variation of algae at Piedade reef.

4. Discussion

Intertidal biota are subjected to the influence of temporal variation related to environmental factors such as temperature which can increase desiccation and salinity that may change due to rainfall. *Chthamalus bisinuatus* showed an increase in the lower and upper intertidal during the dry season, which was not significantly different from the rainy season ($p > 0.05$), this species has been shown to be superior competitor than *Brachidontes solisianus* resisting more to desiccation and growing on the mollusk shell [2].

The zonation patterns and temporal variation of intertidal organisms can maintain biodiversity and allow coexistence with exotic species in intertidal regions, however, competition of *Isognomon bicolor* has decreased cirripedia and bivalve density in Arraial do Cabo, RJ intertidal [12]. *Stramonita haemastoma* was observed on the inferior mesolitoral such as *Colisela subrugosa* during the rainy season which can affect predation of invertebrates and algae and the outcome of competition [4]. Reef sedimentation which occurred at the beach filling of Piedade Beach can be harmful to the local biota [13] by burrowing invertebrates and algae and stressing photosynthesis and recruitment. Previous studies detect the greater density of *Brachidontes solisianus* during the dry season [5] which can show greater resistence to desiccation when compared to *Isognomon bicolor* which together attest the coexistence of these species besides the harmful effect of bioinvasion.

References

[1] Simões, I. P., Guimaraens, M. A., Oliveira-Carvalho, M. F., Valdevino, J., and Pereira S. M. B. 2009. "Floristic Evaluation and Ecological Sucession of Macroalgae in Reefs at Piedade Beach-PE." *Neotropical Biology and Conservation* 4: 49-56.

[2] Guimaraens, M. A., Luz, B. R. A., Silva, J. F., and Carneiro, J. P. S. 2011a. "Modeling the Succession of Barnacles and Mussels on a Sandstone Reef in Pernambuco State, Brazil." *Hydrobiologia* 658 (1): 365-72.

[3] Guimaraens, M. A., Macedo, S. J., Oliveira-Carvalho, M. F., Burgos, D. C., and Pereira S. M. B. 2012. "Modeling Temporal Variations of *Gracilaria* Greville and *Hypnea* J. V. Lamouroux (Rhodophyta) Assemblages on a Midlittoral Reef Platform at Piedade Beach, Pernambuco State, Brazil." *Brazilian Journal of Botany* 35 (4): 377-84.

[4] López, M. S., Coutinho, R., Ferreira, C. E. L., and Rilov, G. 2010. "Predator-prey Interactions in a Bioinvasion Scenario: Differential Predation by Native Predators on Two Exotic Rocky Intertidal Bivalves." *Marine Ecology Progress Series* 403: 101-12.

[5] Guimaraens, M. A., and Dias, V. 2015. "Temporal Variation of Population Structure of the Invasive *Isognomon bicolor* (Mollusca, Bivalvia), *Brachidontes solisianus*(Mollusca, Bivalvia) and *Ulva* spp. (Chlorophyta, Ulvales) Biomass, Pernambuco-Brazil." *International Journal of Marine Science* 43: 1-5.

[6] Domaneschi, O., and Martins, C. M. 2002. "Isognomon bicolor (C.B. Adams) (Bivalvia: Isognomonidae) First Register to Brazil and Redescription of the Species and Consideretions about the *Isognomon*distribution at the Brazilian Coast." *Revista Brasileira de Zoologia* 19: 611-27.

[7] Breves-Ramos, A. 2004. "Distribution, Abundance and Population Structure of *Isognomon bicolor* (Adams, 1845) on the Litoral of Rio de Janeiro State, Brazil." Ph.D. thesis, Universidade Federal do Rio de Janeiro.

[8] Connel J. H. 1961. "Influence of Interspecific Competition and Other Factors on Distribution of Barnacle *Chthamalus stellatus*." *Ecology* 42 (4): 710-23.

[9] Louthan A. M., Doak D. F., and Angert A. L. 2015. "Where and When do Species Interactions Set Range Limits?" *Trends in Ecology and Evolution* 30 (12): 780-92.

[10] Almeida, L. R., Guimaraens, M. A., Luz, B. R. L., and Porto-Neto, F. F. 2008. "Interaction between Colonization and Ecological Succession Processes of Biofouling Communities at Piedade Beach." *Tropical Oceanography* 36: 40-6.

[11] Guimaraens, M. A., Silva, J. M. A., and Falcão, D. 2011b. "Temporal Variability in Macroalgae Recruitment and Succession on Sandstone Reefs at Piedade Beach-PE, Brazil." *Neotropical Biology and Conservation* 6 (3): 170-7.

[12] Ferreira, C. E. L., Junqueira, A. O. R., Villaca, M. C., and Lopes, R. M. 2009. "Marine Bioinvasions in the Brazilian Coast: Brief Reporton History Events, Vectors, Ecology, Impacts and Management of Non-indigenous Species." *In*

Biological Invasions in Marine Ecosystems, edited by Rilov, G. and Crooks, J. A. Berlin: Springer-Verlag, 459-77.

[13] Portugal, A. B., Carvalho, F. L., Carneiro, P. B. M., Rossi S., and Soares, M. O. 2016. "Increased Anthropogenic Pressure Decreases Species Richness in Tropical Intertidal Reefs." *Marine Environmental Research* 120: 44-54.

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Rehabilitation of Semi-mountainous Forest Area Using Bioclimatic Forest Constructions in Greece

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Abstract: Forest constructions are structures erected for serving the forest exploitation and utilization of its products, including recreation. The construction principals of a standard forest village with wooden lodgings apply principles of bioclimatic design and use ecological building materials. It highlights the area and helps to maintain the natural beauty of the forest. Accurate analysis of the area of the forest village requires the creation of topographic plan with great precision. Topographical drawing in AutoCAD in coordinate system HGRS' 87 with contour interval 2 meters with the help of geodetic GPS was created. The aim of this paper was the rehabilitation of a semi-mountainous area taking into consideration environmental, economic, ergonomic and architectural constrains with the help of Google Earth. The area of the camp outside the village of Dadia of Evros Prefecture was granted by the army to the Forest Office of Soufli and remains unexploited until today. The installations were recorded and shown together with the topographic diagram and an image from Google Earth for the understudy-area. All the proposed facilities are presented in a Google Earth image and in a three-dimensional view. The forest village will be composed of 20 wooden lodges with a capacity of 4 persons each. The lodges will be designed around the bioclimatic design, in order to exercise the least impact on the natural environment and to meet the needs of residents for a comfortable and relaxed living. The landscaping was based on better utilization and lower environmental cost of construction in the landscape.

Key words: Forest constructions, forest village, geodetic GPS, landscape, Google Earth, AutoCAD.

1. Introduction

Forest constructions are structures erected for serving the forest exploitation and utilization of its products, including recreation. The construction principals of a standard forest village with wooden lodgings apply principles of bioclimatic design and use ecological building materials. It highlights the area and helps to maintain the natural beauty of the forest.

The bioclimatic design of buildings or the bioclimatic architecture concerns the design of buildings and spaces (internal and external—outdoor) on the basis of the local climate, for the purpose of ensuring conditions of thermal and aesthetical convenience, exploiting the solar energy and other environmental sources, as well as the natural phenomena of the climate [1].

The bioclimatic architecture constitutes one of the most important factors of the sustainable build, which deals with the integration of the environmental parameters on the level of building units, studying the subsequent directions:

(a) The deliberation of the built environment and the problems it engenders (rise of temperature, concentration of gas pollutants, difficulty in air circulation);

(b) The design of buildings;

(c) The selection of the building materials, taking both their thermal and aesthetical properties and their toxicological effect into account.

The efficiency of the bioclimatic design depends on several parameters; a fact that renders it "sensitive" in exogenous and non-technical factors. For this reason,

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basic criteria for the implementation of the bioclimatic design should consist of:

- The simplicity of use in applications and the avoidance of elaborate passive systems and techniques;
- The minor contribution of building's user to the operation of systems;
- The use of widely applied systems;
- The use of techno-economical efficient energy technologies.

The design of wooden residences with bioclimatic features along with selection of suitable eco-friendly materials for these residences has been conducted.

The passive solar architecture in essence is supposed to stand for the architectural design which minimizes the effects of the weather, both in summer and winter.

The term "passive" underlines the significant difference which discerns two distinctive approaches. Solar systems which operate with the help of fans and mechanical pumps are characterized as "active". The term "passive" denotes simple technology and exploitation of energy which inheres in the specific area, in association with architectural components.

For someone to thoroughly understand the essence of the passive systems, it is important to comprehend their basic features [2].

However, it is impossible to aim at the improvement of the environment through technical interventions or measures which relate only to the own separate building, without our intervention in the wider integration; the parameters which define the relations of built—free space, the effects of the city functions, the activities which grow within the city, namely via the structure of space and the usage selected by users. It is required to assess the building in relation to urban planning, researching the consequences of the interdependences and effects, the beneficial or adverse effects of the surroundings, usages and functions, so as principles and resolutions are formulated which could contribute to the attainment of the basic aims:

- The improvement of the environment;
- The energy saving;
- The rational use and management of natural resources, ensuring tolerable living conditions, both within the building and the urban environment, corroborating the parameters which conduce to a positive interdependence among the building and the residential area, the urban space, the climate and the natural environment [3].

For the bulk of the European governments, the struggle against the greenhouse effect partly relies on the growth of the use of wood upon the construction. During the ministerial meeting for the protection of forests in Europe which was convened in Helsinki on June 1993, several scopes corresponded to the great problems were specified, so as the commitments decided at the summit meeting in Rio de Janeiro are determined:

- Sustainable exploitation of forest heritage;
- Containment of the waste upon the exploitation of wood;
- Energy assessment of biomass, so as fossil fuels are spared;
- Increasing the use of wood in the construction business [4].

The aim of this paper was the rehabilitation of a semi-mountainous area taking into consideration environmental, economic, ergonomic and architectural constrains with the help of Google Earth. The area of the camp outside the village of Dadia of Evros Prefecture was granted by the army to the Forest Office of Soufli and remains unexploited until today.

2. Materials and Methods

2.1 Research Area

The Dadia-Lefkimi-Soufli Forest National Park is situated between longitudes 26°01'-26°19' E and latitudes 40°58'-41°15' N in the Regional Department (Region) of East Macedonia-Thrace, in northeastern Greece. The Dadia forest is situated in a low altitude zone (10 to 640 m), the natural vegetation of which belongs, according to Dafis, S. A. in 1973 [5], mainly

to the sub-zone of xerophilous deciduous oaks (Quercionconfertae) of the para-Mediterranean zone (Quercetalia pubescentis). Access to the area of the camp outside the village of Dadia of Evros Prefecture, almost the center of the park is along a 6.5 km local road of the No. 51 national road (Alexandroupoli-Orestiada).

2.2 Methodology

Accurate analysis of the area of the forest village requires the creation of topographic plan with great precision. Topographical drawing in AutoCAD in coordinate system HGRS' 87 with contour interval 2 meters with the help of geodetic GPS was created.

For the design of the residences, it has been assumed that the inhabitants will be static in the interior; that is to say they will not carry out any arduous work.

The best orientation of the residences for the optimum exploitation of the sun is the south-eastern, very close to the south one.

The creation of a technical design, the designing as a conception, has always been and is a constituent part of an engineer's work. A technical project is conceived and initially attributed on paper as a technical design, and subsequently, is constructed by accurately following the instructions which are also depicted on paper in the form of technical design. The technical design should not leave obscurities regarding the building project which is to be constructed and should be carefully performed, discernible, clean, without imperfections and with resistance upon wear and time.

The AutoCAD of the Autodesk Company is one of the best for forest engineering applications which are available on the market, the most widespread and is of general purpose, to wit, can be applied to architecture, statics, topography, hydraulics, road construction and generally to every forest engineering field.

3. Results

The installations were recorded and shown together with the topographic diagram and an image from Google earth for the study area. All the proposed facilities are presented in a Google Earth image and in a three-dimensional view (Table 1, Fig. 1).

The forest village will be composed of 20 wooden lodges with a capacity of 4 persons each. The lodges will be designed around the bioclimatic design, in order to exercise the least impact on the natural environment and to meet the needs of residents for a comfortable and relaxed living. The landscaping was based on better utilization and lower environmental cost of the construction in the landscape (Fig. 2).

Fig. 3 shows the proposal layout for the configuration of the area by placing the buildings, the parking area, the recreation area and tree planting in points needed:

- Gray is the road;
- The blue line defines the recreation area;
- With yellow are the buildings that are placed in two;
- With brown are the paths that will start from the car park and end up in the buildings;
- Dark green is the old buildings that will be demolished and to their existing outline to build flower beds that will remind the previous use of the area;
- With light green are trees to be planted;
- The parking area is nearby the recreation area.

Table 1 Points that encompass the region of study.

School	East	North
1	686026.066	4554349.882
2	686163.166	4554683.765
3	686253.073	4554717.186
4	686430.736	4554828.900
5	686479.645	4554817.956
6	686577.351	4554563.018
7	686581.446	4554511.479
8	686553.521	4554448.725
9	686551.119	4554422.481
10	686478.115	4554359.347
11	686365.001	4554365.319
12	686188.378	4554313.753

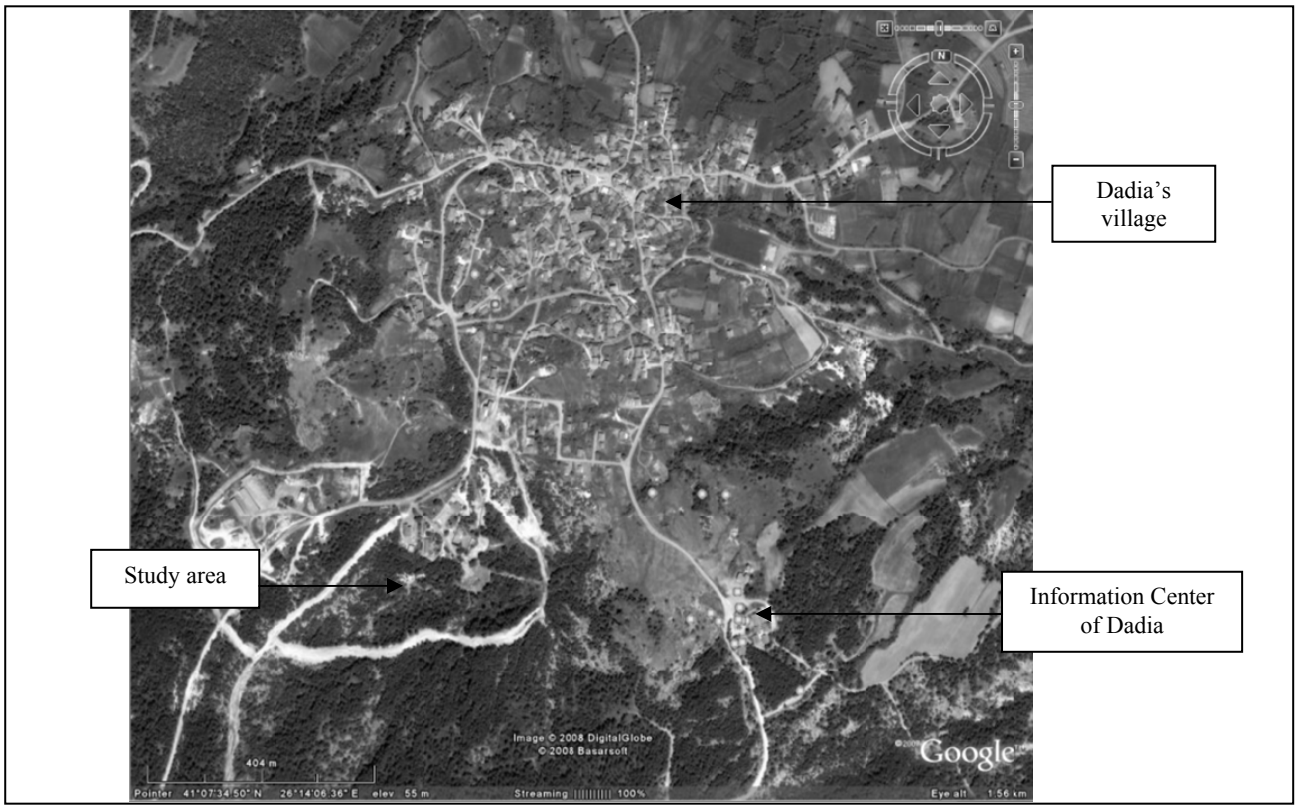

Fig. 1 Picture from the Google Earth for the region of Dadia.

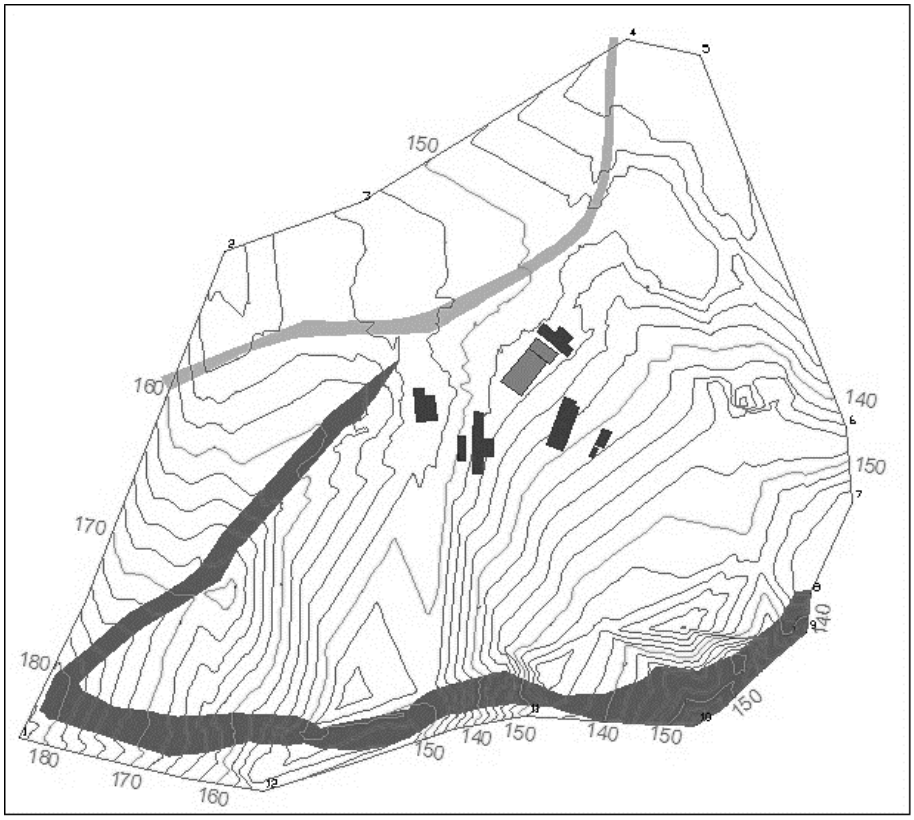

Fig. 2 Topographic diagram of the region.

Fig. 3 Picture from the Google Earth with the new configuration.

4. Analysis and Discussion

The area of the camp outside the village of Dadia of Prefecture Evros granted by the army in Forest Office of Soufliou remains untapped till today. Due to the growing development of the village of Dadia and due to the rare birds of prey, it is proposed to construct a forest village based on bioclimatic design.

The forest recreation area that is studying because it is going to be used to rest and relaxation the modern man, must offer a very good level of accommodation for visitors with all the comforts of modern times. The specific area for the creation of the forest village is chosen for the double goal that is achieved by its exploitation. On the other hand, there is the rehabilitation of a disturbed area and, on the other hand, the need to host more and more visitors in the forest of Dadia.

For the development of mountain tourism better siting for the necessary accommodation could not exist from the mountain villages. There are basic infrastructures (road access, electricity, water supply and telecommunications). Visitors to the mountainous regions, alongside the acquaintance with nature, also want to get familiarized with the local communities (manners and customs, linguistic idioms, local cuisine, etc.). Every natural sight of the mountainous region can be approached by the visitor in a very short time, based on the mountain villages. There is no reason to cause interventions in the heart of the natural environment with new infrastructure (roads, electricity-water supply networks, telecommunication lines and antennas) which in any case have smaller or greater impact on the environment and degrading the landscape.

The choice of this location does not contradict the above because it is very close to the village of Dadia.

The need for a further road network does not exist as there is already an asphalt road until the entrance of the proposed forest village. No further basic infrastructures (electricity, water supply, telecommunications) are needed because of the site was formerly used and these are exist but need modernization. The forest village is not in danger of forest fires due to the pre-existing buffer zone that protected the camp.

In the village, there is a private 20-bed guest house and the Dadia information center can accommodate guests. The construction of the forest village does not operate competitively with the existing facilities; on the contrary, it enhances the possibility to accommodate more visitors in the village of Dadia. The construction of the forest village will allow visitors to have the village of Dadia as their base, thus allowing more visitors to stay longer in the village of Dadia than a simple visit to the wildlife information center. More time in order to explore wildlife and getting acquainted with the local community has the visitors, achieving economic development of the village through agrotourism.

During the planning of the forest village, apart from the bioclimatic design of the buildings, attention was paid to the restoration of the landscape. Existing houses are proposed to be demolished and to their existing outline to build flower beds that will contain shrubs, trees and flowers. A building, when demolished, dies, but with the above rehabilitation design helps to keep these buildings monuments that betray the previous use of the area. In the rest of the area, it is proposed to planting with native species in order to have the best possible landscape restoration. A part of the camp will become a parking area for the visitors' vehicles and next to it will be a delimited recreation area with kiosks (gazebos), barbecues, playground, etc. Access to the buildings will become a network of paths that starts from the parking area and will not exceed 5 minutes walking. The buildings provide all the modern amenities and there is no need to create a large central building that would not fit with the environment.

The removal of some trees is necessary for the installation of the buildings and their surrounding area, but it is compensated by the tree planting of most of the camp. The buildings were placed in such manner within the study area so that the visitor can find the peace and quiet he is looking for, but on the other hand, he does not feel cut off from the whole. Glades and open spaces were preferred for the placement of the buildings in order to minimize the removal of trees and vegetation. The slope of the paths in the area is mild, so that it does not cause fatigue but a pleasant walk through the forest to the house. Marking and demarcation with wooden rails of the paths is very important for facilitating access to the buildings. The configuration of the surrounding area of the buildings is very important for the operation of their bioclimatic characteristics, which is also the purpose of the study.

The buildings in the forest village were constructed according to the principles of bioclimatic design. Wood was used to build them as recyclable natural material. For the heating of the rooms, the use of the fireplace was preferred. Outside the roof of the houses was constructed in such a way that in the winter when the sun is lower, it is easier to heat the houses, and on the other side, in the summer when the sun is upper, to prevent the entrance so be cool and not need other means for cooling.

5. Conclusion

For the wider area of the forest village, it is recommended: restoration of the vegetation to the west of the camp that served as a parking area for military vehicles, improvement of the road network to the village of Dadia, creation of information material for all visited places of the area.

The building or construction of forest engineering works should be pursued: the simple and elegant construction but economically advantageous, because

every luxury in its appearance is expensive and unusual for the intended purpose. With the building or construction of forest engineering projects should be pursued: the simple and elegant construction, but cost-effective, because every luxury in appearance is costly and ineffective for its intended purpose.

References

[1] CRES (Centre for Renewable Energy). 2002. Operational Programme for Energy, Bioclimatic Design in Greece, Energy Efficiency and Guidelines for Implementation. Athens: Pikermi, 1-51.

[2] Colombo, R., Landabaso, A., and Sevilla, A. 1995. Manual Design, Passive Solar Architecture for the Mediterranean Region. Joint Research Centre, European Commission, Institute for Systems Engineering and Informatics, 15-45.

[3] Gauzin-Muller, D. 2003. Ecological Architecture. Thessaloniki: Ktirio Publications, 45.

[4] Tsipiras, S. K., and Tsipiras, S. T. 2005. Ecological Architecture. Athens: Kedros Publications, 34.

[5] Dafis, S. A. 1973. "Classification of the Forest Vegetation of Greece." In Scientific Annals of the Agronomy and Forestry School, 75-86.

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Economic Analysis of Minimizing Environmental Cost Caused by Outdoor Advertising

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Abstract: The optimal consent ration C_{opt} of pollutant advertising in the environment can be determined as an equilibrium point in the trade off between the environmental cost, due to impact on man/land/economy and the economic cost for environmental protection. These two conflict variables are internalized within the same techno-economic objective function of total cost, which is minimized. Last, sensitivity analysis of C_{opt} as regards the impact of the increase of environmental information/sensitization and the decrease of interest rate reveals a shifting of C_{opt} to lower and higher values, respectively, certain positive and negative implications (i.e. shifting of C_{opt} to lower and higher values, respectively) caused by socioeconomic are also discussed.

Key words: Environmental cost, optimization, advertising, land.

1. Introduction

The economic analysis of the environmental cost of outdoor advertising in real estate involves matching the environmental to the socio-economic benefit [1, 2]. By analogy, economic analysis of the principle/consensus *'think locally, act globally'* and the (now known on a theoretical and practical basis) inverse *'think globally, act locally'*. Although these principles usually have a reference to environmental pollution, they can be used in solid waste and aesthetic pollution caused by outdoor advertising [3, 4].

2. Methodology

The analysis of the subject may include qualitative and quantitative characteristics. The effort to minimize the environmental costs invoked by outdoor advertising is graphically represented by the CPM (Contingent Valuation Method) [5]. Table 1 shows the number of activities required and the completion time in days [6, 7]. The background analysis is based on a dynamic approach [8, 9]. The activities include the description of the techno economic/environmental system under consideration, the identification of the scientific disciplines forming the constituent sub-systems and the discrimination of the most relevant topics within these sub-systems, i.e. the individual lands where take place the advertising activity.

Environmental standards, as independent/explanatory variables of capital cost determination functions may refer to spatial points in order to protect subsystems that have a particular sensitivity or/and importance [10]. In such cases, a quantitative link is applied linking the environmental characteristics of the source of the pollution source to those of the reference points/control [11].

3. Results and Discussion

The minimization of environmental costs can be used as a criterion for determining the optimal value of concentration C of a pollutant in the environment, that is to say, a property hosting outdoor advertising. In the most common case, where socio-economic costs and private economic costs are conflicting

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Table 1 CPM chart for building an outdoor advertising infrastructure project with minimizing environmental costs.

Activity number	Time of completion (in days)
1. Project notice	2
2. Awarding a project to a carrier	6
3. Geography of the region	3
4. Identifying advertising needs	3
5. Recording of existing infrastructures	3
6. Specifying alternatives	1
7. Technical design of outdoor advertising	6
8. Technical study on the use of special materials	6
9. An economic study of building infrastructure for outdoor advertising	3
10. Economic study of the use of special materials	2
11. Environmental Impact Study for Building Infrastructure for Outdoor Advertising	2
12. Environmental impact assessment of use of special materials	2
13. Choice of best alternative from Scholar	1
14. Construction of infrastructure for outdoor advertising	8
15. Applications of special materials	6
16. Trial operation	4
17. Repair imperfections in the infrastructure	3
18. Recheck on the use of materials	2
19. Advertising quality control	1
20. Delivery - operation	1

Table 2 Prerequisites for the CPM method.

Activity	Prerequisites
2	1
3, 4, 5	2
6	3, 4, 5
7	6
8	6
9	7
10	8
11	9
12	10
13	7, 8, 9, 10, 11, 12
14	13
15	13
16	14, 15
17	16
18	16
19	17, 18
20	19

variables, the environmental cost, which is the sum of these variables, presents a single internal minimum if social cost and private cost are functions of C, are also continuous and monotonous. If the marginal socio-economic cost curves and marginal private economic cost curves are used, the optimal C_{opt} value is easily determined from the point of intersection of the marginal cost curves. Reducing the size of advertising may cause a shift in the cost of private finance with modern economies of scale, a reduction in the cost of privatization with the adoption of anti-pollution technology, a change in the socio-economic cost curve according to the perceptions of an environmentalist whose basic view is the environment after all else, and a change in the socio-economic cost curve, according to the perceptions of a 'developmentist', whose basic view is first of all, after everything else.

4. Conclusion

In conclusion, the functionality of the methodological framework, it is developed under the form of a logical flow chart for optimizing parameter values and independent variables has been proved by using the tradeoffs between societal/environmental and private/techno economic cost and system reliability and design/construction cost. It is worthwhile noting that both tradeoffs, the first based on cost minimization and the second based on benefit maximization, represent interdisciplinary objective functions, since their paramaters belong to the domains of Technology, Economics and Environmental Science (which is, in its turn, a multidisciplinary field).

Reference

[1] Ajzen, I., Brown, T. C., and Rosenthal, L. H. 1996. "Information Bias in Contingent Valuation: Effects of Personal Relevance, Quality of Information and Motivational Orientation." *Journal of Environmental Economics and Management* 30 (1): 43-57.

[2] Bedate, A., Herrero, L. C., and Sanz, J. A. 2004. "Economic Valuation of the Cultural Heritage:

Application to Four Case Studies in Spain." *Journal of Cultural Heritage* 5 (1): 101-11.

[3] Kahneman, D., and Knetsch, L. J. 1992. "Valuing Public Goods: The Purchase of Moral Satisfaction." *Journal of Environmental Economics and Management* 22 (1): 57-70.

[4] Bateman, I., Munro, A., Rhodes, B., Starmer, C., and Sugden, R. 1997. "A Test of the Theory of Reference-Dependent Preferences." *The Quarterly Journal of Economics* 112 (2): 479-505.

[5] Brown, T. C. 2005. "Loss Aversion without the Endowment Effect, and Other Explanations for the WTA-WTP Disparity." *Journal of Economic Behavior and Organization* 57 (3): 367-79.

[6] Hanemann, W. M. 1991. "Willingness to Pay and Willingness to Accept: How Much Can They Differ?" *The American Economic Review* 81 (3): 635-47.

[7] Horowitz, J. K., and McConnell, K. E. 2003. "Willingness to Accept, Willingness to Pay and the Income Effect." *Journal of Economic Behavior and Organization* 51 (4): 537-45.

[8] Kling, R. W., Revier, C. F., and Sable, K. 2004. "Estimating the Public Good Value of Preserving a Local Historic Landmark: The Role of Non-substitutability and Citizen Information." *Urban Studies* 41 (10): 2025-41.

[9] Kopsidas, O., and Batzias, F. 2011. "Improvement of Urban Environment and Preservation of Cultural Heritage through Experimental Economics by a Modified Contingent Valuation Method (CVM)." *Recent Researches in Energy, Environment, Devices, Systems, Communications and Computers* 157-62.

[10] Liao, T. F. 1994. *Interpreting Probability Models: Logit, Probit, and Other Generalized Linear Models*. London: Sage Publications Inc., 101.

[11] Menard, S. 2001. Applied Logistic Regression Analysis (2nd ed.). London: Sage Publications Inc..

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The Use and Value of Green School Grounds in Developing Countries

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Abstract: There is an extensive attention in developed countries to take full advantages of urban green spaces including green school grounds. Those spaces are assessed and established as environmental learning resources, where top-down or bottom-up initiatives encourage or initiate projects with the support of school staffs and students. Green school grounds are also used for gardening (food growing) that besides environmental education, those spaces provide health benefits and knowledge, also skills and behavioral benefits. Those approaches in some developing countries are still vague or inapplicable for several reasons. This paper addresses the use and value of school grounds in developing countries as it lacks the opportunities to make the most of green school grounds. This research elaborated five schools, in the city of Podujevo, Kosovo. The findings reveal that the potentials of green school grounds in most of the cases studied have not been utilized. Opportunities offered by the municipality and environmental NGOs (Non-governmental Organizations) are insufficient. The findings suggest the need to rethink the design and use of green school grounds in developing countries.

Key words: School, environment, school gardening, children's gardens, experimental learning.

1. Introduction

Green school grounds are utilized as places to facilitate formal, informal and non-formal environmental learning and experiences [1, 2]. Environmental education has gained attention in the last decades about the role it may have to facilitate the current environmental challenges [3, 4, 6]. From 2005, UNESCO has announced the UN Decade of Education for Sustainable Development. That seeks to "integrate the values inherent in sustainable development into all aspects of learning to encourage behavior changes that allow for a more sustainable and just society for all" [5]. Such statements indicate the necessity for environmental education and awareness to be integrated into all levels of education.

Regarding green school grounds as education platforms have been conceived long back from 19th century, Howard, E. [7] emphasize: "School gardens might be made the means of giving the young an insight into horticulture, the effect of which they would find pleasant and profitable in afterlife….. the school garden would be the most valuable of object-lessons".

Today, studies show that school-based garden programs have significant knowledge and health effects on students [8]. School gardens provide a dynamic environment in which students [1] can experiment, discover, observe and interact with nature. The assessment of school garden as living laboratory where students can gain an understanding of ecosystems, food origins, the value of nutrition, including knowledge of plant and animal life cycles [6, 9, 10]. Scholars examining urban green commons have pointed to varied ways that food production can foster social-ecological memory [11].

On their research Robinson, C. W. and Zajicek, J. M. [12] analyzed the effects of the one-year school

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[1] On this paper the term students refer also to pupils.

garden program. They conclude that the youth that participated in the yearlong garden program enhanced teamwork skills and self-understanding also overall life skills. A school garden is considered as an 'innovative teaching tool and strategy that lets educators incorporate hands-on activities in a diversity of interdisciplinary, standards-based lessons' [10].

School gardens are also promoted by cities food strategies, the Mayor's Food Strategy proposes to 'promote existing opportunities for individuals and communities to grow food, through gardens, orchards, schools, allotments and parks and open spaces' also consider developing and expanding these in response to demand [13].

Those new approaches are essential to encourage social responsibility and educate future productive citizens. Local authorities have a crucial role in fostering these new approaches and reconsider the patterns of green school grounds toward productive and multifunctional approaches.

2. Methods

With a view to having a greater understanding of use and value of green school grounds in developing countries, case studies were done at five schools in Podujevo, Kosovo. Three primary[2] schools; Naim Frashëri, Shaban Shala, and Enver Maloku and two secondary schools; Aleksandër Xhuvani and Fan S. Noli. Data collection include five interviews face-to-face with schools' directors and three interviews with municipal staffs including the representatives of the department for education in Podujevo. The interviews were realized from February to May 2018. The time spent per interview lasted between 30 and 60 minutes depending on how much information the school had to offer. The semistructured interviews consisted of a series of open and closed questions that explored the use, value, design, future plans, maintenance, children and staff engagement, teaching and outdoor learning on the green school ground. Also, the assessment through observation of green school grounds has been done by the author. Moreover, local documents have been analyzed including the urban development plan (2012-2022) and the Local Action Plan on Environment (2012/2017). Most of the documents belong to strategic planning as they provided long-term visions, objectives, and measures for further development of the planning area.

[2]A primary school in Kosovo is a school in which children receive elementary and primary education, comes after preschool and before secondary school.

3. Findings and Discussion

This study found that majority of schools in Podujeve have vaster outdoor school grounds. However, the investments seem insufficient as several schools have very few trees or proper green school grounds. At this condition, most of the school grounds does not offer much to be utilized for environmental/experimental learning. All the schools analyzed have taught courses related to the environment, for instance 'the spatial environment' yet those courses remain at a theoretical level.

The front school ground of Fan S. Noli (Table 1) can be considered relatively maintained compare to other schools, there are some trees, pines and shrub pines planted but the variety is very limited. Planning and design of the site have been done by the school students of architecture department. Also, the planting has been done in collaboration with the students, municipality, teachers and donators. The director of the school Ms. Hajdini, V. [14] stated that they had required 100 more ornamental trees to be granted by DKA (Municipal Directorate for Education) and the request is still under review by DKA.

Also, Shaban Shala school (Table 2) have several green sites, but the type of trees is also limited (ornamental trees, pine and shrub pine). The municipality donated some of the trees and pines planted, and some are donated by students' parents.

In the process of planting and stewardship of green school grounds students are not much engaged only

Table 1 Data of secondary school Fan S. Noli and green school ground views.

Specifics	Site area: 2.74.79 ac	Number of staffs: 78	Number of students: 1080
Views			
Location			

Source: author.

Table 2 Data of primary school Shaban Shala and green school ground views.

Specifics	Site area: 87 acres	Number of staffs: 79	Number of students: 1304
Views			
Location			

Source: author.

on special occasions or annual event celebration like 'Earth day'. It can be concluded that environmental stewardship is still a new concept and inapplicable, the maintenance of green areas is done mainly by technical workers of the school.

Another phenomenon found in this school is that around green areas there were fences (to protect from potential vandalism) that can increase the level of disengagement. Gardening and tree planting programs for children in surrounding environment has been proven to foster environmental stewardship and the positive values that comes from living with plants [15]. The limited interaction with nature in childhood experiences may lead to passive adults [4, 16].

The exchanged location of Aleksandër Xhuvani and Enver Maloku has prolonged the development of one site. The school's relocation was done in 2016, on the previous location of Enver Maloku, now is a new building of Aleksandër Xhuvani. Aleksandër Xhuvani school ground is not developed (Table 3) as the construction from 2009 have not been finished yet, said the director of the school Mr. Salihu, N. [17] During this year, they are expecting everything to be finished including the outdoor environment, having said that at the entrance of the school can be seen some shrub pines planted already. Neither this leaves much to be anticipated as the design does not include anything besides ornamental trees and pines. It can be highlighted that facilities offered on school grounds do not provide many possibilities for students' engagement. Moreover, it can be highlighted that those places are not much-valued from all instances, starting from the municipality, NGOs and at the school level. Both schools have spaciously but undeveloped school grounds. Based on the Local Environment Action Plans 2012/2017, Aleksandër Xhuvani (the current location of Enver Maloku's school) has been on the action plan-priority projects list. For a shared donation of 60,000 euro to improve school ground, allocated for implementation period in 2012. The project holders were municipality and donors (not specified) however, no investments were seen on the school ground based on current school ground conditions [18].

Based on empirical assessment, on the current school ground of Enver Malokuhas, very few trees planted as result of the initiative of the school director Mr. Hamza, A. [19], this initiative has been supported also by students and their parents. They have planted around 25 trees in 2017 as can be seen from the photos on Table 4.

The director of the school has required 500 ornamental trees at DKA and the ministry of agriculture, forestry and rural development but no donation were provided. The reason that municipality has rejected was the lack of budget while the ministry of agriculture, forestry and rural development did not classify green school grounds as a potential place for donation.

Dudek, M. [20] states that green school grounds should be merged to educational experiences because they can play a significant role in the process of developing knowledge. As many of the cases studied neither school ground of Naim, Frashëri can be utilized as a platform for the environmental educational experience. Despite that the school was built in 2016, the school ground is not in good condition. According to the deputy director Mr. Hasani, B. [21] of the school, there was an investment on the school ground, where they planted grass and around 200 shrub pines, however, for unknown reasons, only few shrub pines survived.

School's technical workers have done planting of shrub pines, students were not engaged in the process. This year the school has planted few ornamental plants (flowers) with a small investment of parents and have engaged students on their activities (Table 5). The deputy director stated that they had required 200 ornamental trees but the DKA calmed that there is no sufficient budget [21].

Table 3 Data of secondary school Aleksandër Xhuvani and green school ground views.

Specifics	Site area: /	Number of staffs: 90	Number of students: 1850
Views			
Location			

Source: author.

Table 4 Data of primary school Enver Maloku and green school ground views.

Specifics	Site area: 7.11 ac	Number of staffs: 78	Number of students: 1080
Views			
Location			

Source: author. Photos © Hamza, 2018.

Table 5 Data of primary school Naim Frashëri and green school ground views.

Specifics	Site area: Around 62 acres	Number of staffs: 73	Number of students: 1107
Views			
Location			

Source: author and photo with children © Hasani 2018.

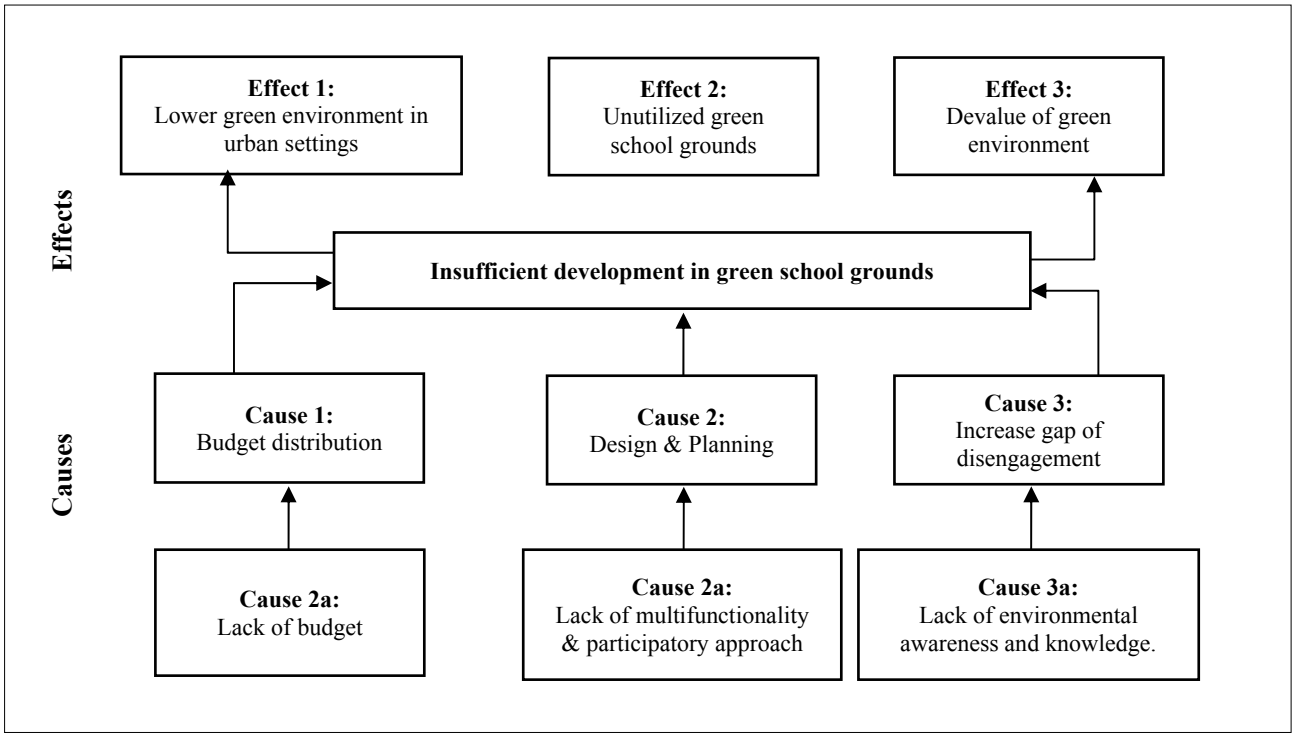

Fig. 1 Major challenges analysis: causes and effects of insufficient development in green school grounds. Source: author.

In the framework of the Local Action Plan on Environment, an allocation of 2000 euro in the so-called "Green Package of Education" for all schools [18]. However, this package (investment) is a bit unclear in its objectives and implementation. This package aimed to raise environmental awareness for students but with no practical possibilities that remain at a theoretical level. Moreover, on the project for

enhancement of school grounds that were allocated 60,000 euro, there were no specification or linkage where emphasized the raising environmental awareness for students. The objectives of this project were to create "attractive place for students", and the expected results were to create "Beautiful view of schools and clean environment" [18]. Despite that, the lack of green spaces has been highlighted on Local Action Plan on Environment under the section of "Priority Issues List by Respondents". In the same time, the lack of environmental awareness is specified [18] but investments and planning do not show to create a mechanism to merge those issues. Green school grounds seem to be valued mainly for esthetical aspect. There was no proper consideration of values and use that school grounds can provide regarding social-cultural, ecological, functional and educational aspects. Fig. 1 presents intercorrelations of causes and effects of insufficient development in green school grounds. The lack of budget and proper management lead to insufficient and improper green school grounds. Planning and designing contributed to this uncertainty of enhancing green school grounds. Consequently, the disengagement is higher that can lead to devaluing of green environments.

4. Conclusion

In this paper, the value and use of green school grounds in Podujevo were analyzed. Major challenges in green school grounds were identified (Fig. 1). An analysis of planning documents revealed that the lack of green spaces and need for the rise of environmental awareness is targeted. However, the use of schools ground was not mentioned explicitly.

Green school grounds can provide opportunities for increasing urban green spaces and rising environmental awareness. Moore, R. C. [4] states that children gardening is the first steps towards a sustainable future. Green school grounds can be designed in more multifunctional approached and embraced environmental stewardship as a tool to connect children to nature. Thus, all actors involved should contribute to ensuring that green school grounds are designed and developed to provide excellent linkages for environmental, experimental learning. Moreover, school grounds could be considered as strategic places of increasing urban green spaces and as a platform for raising environmental awareness.

One option to adequately develop and maintain existing green school grounds might involve a focus on considering multifunctionality and offering opportunities for students to experience gardening in schools. This should be undertaken as part of a larger regenerative design process. In this context, the consideration of multifunctional approach helps to better communicate several benefits that student and citizens can gain from green school grounds. As Moore, R. C. [4, 22] highlighted, research and design programs should encourage the natural environment in the daily lives of children. In many societies, an increasing lack of emphasis on outdoor engagement is so prevalent today [4, 22, 23]. Finally, the case study of Podujevo may help to better understand the narrow and unproductive approaches for green school grounds design and development. Future research could include a comparative study which has some similar investment opportunities but fosters better and more sustainable solutions.

References

[1] Dyment, J. E. 2005. "Gaining-Ground: The Power and Potential of School Ground Greening in the Toronto District School Board." Evergreen. Accessed February 9, 2018. https://www.evergreen.ca/downloads/pdfs/Gaining-Ground.pdf.

[2] Titman, W. 1994. *Special Places, Special People: The Hidden Curriculum of School Grounds*. Godalming: WWF.

[3] Cutter-Mackenzie, A. 2009. "Multicultural School Gardens: Creating Engaging Garden Spaces in Learning about Language, Culture and Environment." *Canadian Journal of Environmental Education* 14 (1): 122-35.

[4] Moore, R. C. 1995. "Children Gardening: First Steps

Towards a Sustainable Future." *Children's Environments* 12 (2): 222-32.

[5] UNESCO. 2009. "DESD Quarterly Highlights." UNESCO. Accessed April 30, 2018. http://www.unesco.org/education/DESDquarterlyAug09.pdf.

[6] UNESCO. 2016. *Planet: Education for Environmental Sustainability and Green Growth*. Global Education Monitoring report, Paris.

[7] Howard, E. 1899. "To-morrow: A Peaceful Path to Real Reform." *The Economic Journal* 9 (33): 71.

[8] Blair, D. 2009. "The Child in the Garden: An Evaluative Review of the Benefits of School Gardening." *The Journal of Environmental Education* 40 (2): 15-38.

[9] Bristol City Council. 2015. "One Tree Per Child." Bristol City Council. Accessed February 25, 2017. https://www.bristol.gov.uk/museums-parks-sports-culture/one-tree-per-child.

[10] California School Garden Network. 2006. *Gardens for Learning: Creating and Sustaining Your School Garden*. Irvine, CA: California School Garden Network.

[11] Colding, J., and Barthel, S. 2013. "The Potential of 'Urban Green Commons' in the Resilience Building of Cities." *Ecological Economics* 86: 156-66.

[12] Robinson, C. W., and Zajicek, J. M. 2005. "Growing Minds: The Effects of a One-year School Garden Program on Six Constructs of Life Skills of Elementary School Children." *Hort Technology* 15 (3): 453-7.

[13] London Developement Agency. 2006. "Healthy and Sustainable Food for London-The Mayor's Food Strategy." Accessed April 9, 2018. https://www.london.gov.uk/sites/default/files/the_mayors_food_strategy_2006.pdf.

[14] Hajdini, V. 2018, April 30. "Personal Communication (Interview), the Director of the School Fan S. Noli."

[15] Lohr, V. I., and Pearson-Mims, C. H. 2006. "Responses to Scenes with Spreading, Rounded, and Conical Tree Forms." *Environment and Behavior* 38 (5): 667-88.

[16] Louv, R. 2005. *Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder*. Chapel Hill, N.C: Algonquin Books.

[17] Salihu, N. 2018, May 14. "Personal communication (Interview), the Director of the School Aleksandër Xhuvani."

[18] REC. 2012. "Local Action Plan on Environment 2012/2017." REC. Accessed May 21, 2018. http://documents.rec.org/publications/LEAP_Podujeve_AL.pdf.

[19] Hamza, A. 2018, May 24. "Personal communication (Interview), the Director of the School Enver Maloku."

[20] Dudek, M. 2007. *Schools and Kindergartens: A Design Manual*. Walter de Gruyter.

[21] Hasani, B. 2018, May 29. "Personal communication (Interview), the Deputy Director of the School Naim Frashëri."

[22] Moore, R. C. 1993. *Plants for Play: A Plant Selection Guide for Children's Outdoor Environments*. Berkeley: Mig Communications.

[23] Moore, R. C., and Wong, H. H. 1997. *Natural Learning: The Life History of an Environmental Schoolyard*. Berkeley, Calif.: Mig Communications.

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