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An application of some intuitionistic fuzzy modal operators to agriculture

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Abstract: Herewith proposed is an application of elements of the theory of intuitionistic fuzzy sets to a problem from the area of agriculture, namely application of different intuitionistic fuzzy operators to the problem of ensuring economic irrigation of farmland.

We start from the assumption that the separation of an agricultural area can be done in the same way as the separation of image. Separating an area requires the use of certain variables, and the proposed application exhibits a variety of such variables like temperature, level of afforestation, type of trees, various characteristics of soil, including soil moisture, slope of the terrain, air humidity in agricultural area, etc. From all these variables, we have chosen to include in our model the type of soil, air humidity and soil humidity.

For the purpose of the present research, we benefit from the definition of membership function implementing the enhancement algorithm as described with membership functions in [8] and $Z^{\omega}_{\alpha,\beta}$, $F_{\alpha,\beta}$, $B_{\alpha,\beta}$ as described in [2,3]. These operators were used for optimal tuning the variables in the economic irrigation model.
Keywords: Intuitionistic fuzzy modal operators, Agricultural application, Intuitionistic fuzzy logic, Contrast enhancement.
AMS Classification: 03E72.

1 Introduction

Intuitionistic Fuzzy Sets were defined by Atanassov, in 1983 in [1]. Some applications of this theory were used in various areas such as contrast enhancement, control systems, robotics, etc. Herewith proposed is application of elements of the theory of intuitionistic fuzzy sets to a problem from the area of agriculture, namely application of different intuitionistic fuzzy operators to the problem of ensuring economic irrigation of farmland.

Our basic assumption is that the separation of an agricultural area can be done in the same way as the separation of an image. In addition to results of other authors, developing approaches to intuitionistic fuzzy estimation of the area of 2D-figures, [6, 7], we use here our previous results, where the application of the intuitionistic fuzzy modal operator $E_{\alpha,\beta}$ to agricultural areas was studied in [3]. Separating an area requires the use of certain variables. There is a variety of such variables like temperature, level of afforestation, type of trees, various characteristics of soil, including soil moisture, slope of the terrain, air humidity in agricultural area, etc. From all these variables, we have chosen to include in our model the type of soil, air humidity and soil humidity.

For this purpose, we benefit from the definition of membership function implemented the enhancement algorithm as described with membership functions in [8] and $Z^{\omega}_{\alpha,\beta}$, $F_{\alpha,\beta}$, $B_{\alpha,\beta}$ as described with intuitionistic fuzzy sets in [2,3]. These operators were used for optimal tuning the variables in the economic irrigation model.

Intuitionistic fuzzy modal operators provide a lot of suitable algorithms in several areas. They can be also used for estimation of agricultural parameters. While soil is irrigated, soil irrigation should be made step by step in order to absorb more water. For determining the levels of irrigation, we will use intuitionistic fuzzy operators. We apply these operators for area in three or more steps. In this way, the goal is, using the process proposed in this paper, to have less water used than in traditional irrigation systems. We will examine intuitionistic fuzzy modal operators $Z^{\omega}_{\alpha,\beta}$, $F_{\alpha,\beta}$, $B_{\alpha,\beta}$ for this purpose.

Definition 1. *[2] An intuitionistic fuzzy set (shortly IFS) on a set X is an object of the form*

$$A = \{\langle x, \mu_A(x), \nu_A(x)\rangle : x \in X\}$$

where $\mu_A(x), (\mu_A : X \to [0,1])$ is called the "degree of membership of x in A ", $\nu_A(x), (\nu_A : X \to [0,1])$is called the " degree of non-membership of x in A ", and where μ_A and ν_A satisfy the following condition:

$$\mu_A(x) + \nu_A(x) \leq 1, \text{for all } x \in X.$$

Definition 2. *[2], [3] Let A be an intuitionistic fuzzy set on X then the followings are intuitionistic fuzzy one, two and uni type modal operators, respectively,*

1. $Z^{\omega}_{\alpha,\beta}(A) = \{\langle x, \beta(\alpha\mu_A(x) + \omega - \omega.\alpha), \alpha(\beta\nu_A(x) + \omega - \omega.\beta)\rangle : x \in X\}$
2. $F_{\alpha,\beta}(A) = \{\langle x, \mu_A(x) + \alpha\pi_A(x), \nu_A(x) + \beta\pi_A(x)\rangle : x \in X\}$
3. $B_{\alpha,\beta}(A) = \{\langle x, \beta(\alpha\mu_A(x) + 1 - \alpha)\nu_A(x), \alpha((1-\beta)\mu_A(x) + \nu_A(x))\rangle : x \in X\}$

For our study, we use an area as in Figure 1. We study different types of plants cultivated in this farm, which feature varying parameters of temperature, slope of the terrain, soil moisture and air humidity. In this case, this farmland can be separated domain by domain as shown in Figure 2. After this operation, every domain will be separated with respect to these variables, as given in Figure 3.

Figure 1

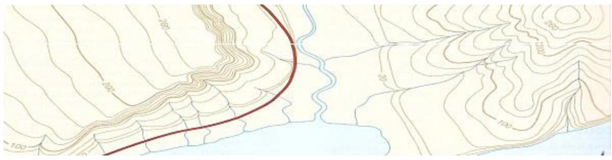


Figure 2

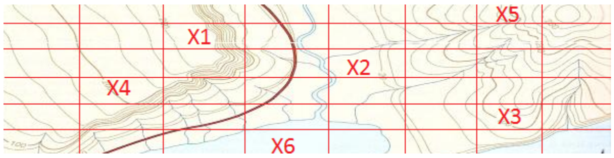
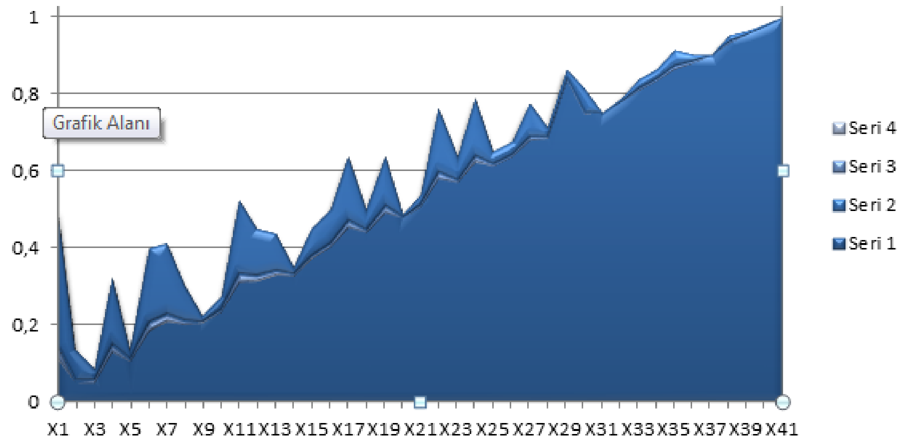


Figure 3

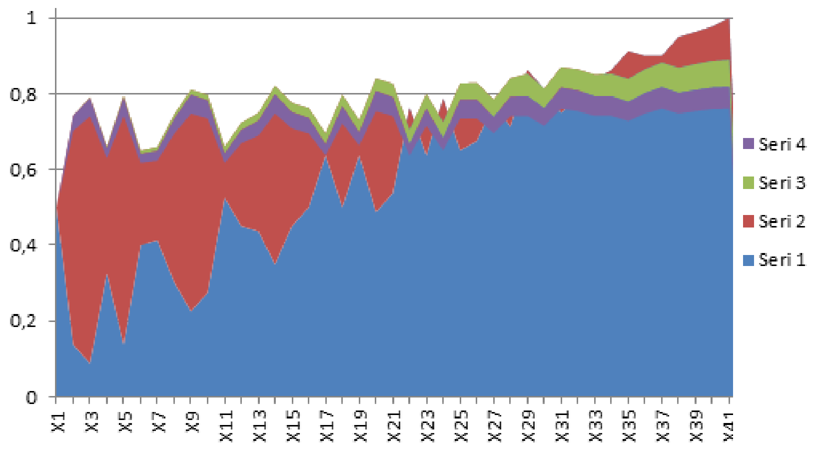
We will use some properties of intuitionistic fuzzy sets and the modal operators $Z^{\omega}_{\alpha,\beta}$, $F_{\alpha,\beta}$, $B_{\alpha,\beta}$, which are defined on the intuitionistic fuzzy sets. From the definition of the $Z^{\omega}_{\alpha,\beta}$, $F_{\alpha,\beta}$, $B_{\alpha,\beta}$, we can use some value such as α, β, ω. α, β and ω are considered to be used for calculating the level of humidity and the number of steps of watering. In addition, α, β, $\omega \in [0, 1]$ and they do not affect each other.

2 The use of intuitionistic fuzzy modal operators in agricultural applications

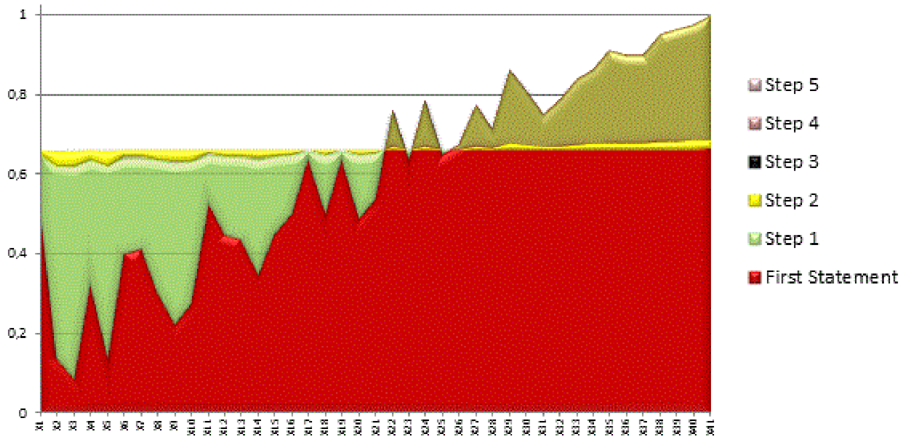
We give geometrical interpretations of operators $F_{\alpha,\beta}$, $B_{\alpha,\beta}$ and $Z^{\omega}_{\alpha,\beta}$ respectively in Graph 1, Graph 2 and Graph 3 for the model of irrigation of agricultural areas. In the graphs, it can be easily seen that $F_{\alpha,\beta}$ and $B_{\alpha,\beta}$ are not enough for estimation of an appropriate irrigation process. For this reason, it can be easily seen in above graphs, the application of $F_{\alpha,\beta}$ and $B_{\alpha,\beta}$ on agricultural models for the performance of irrigation is not as suitable as $Z^{\omega}_{\alpha,\beta}$, so in this study, we will use $Z^{\omega}_{\alpha,\beta}$.



Graph 1



Graph 2



Graph 3

3 The use of $Z^{\omega}_{\alpha,\beta}$ operator for estimation of models in agricultural areas

There are seven types of soil; stony soils, sandy soils, loamy soils, clay soils, marl soils, humus soils, calcareous soils. Every kind of soils has different the level of water retention. It is necessary to determine the level of water retention for every kind of soils.

We set the parameter α in $Z^{\omega}_{\alpha\beta}$ to determine the kind of soil. For example, $\alpha \leq 0.2$ for humus soil and $\alpha \geq 0.5$ for sandy soil.

Sandy soil needs to water more than other types of soils. In addition, such agricultural areas are watered frequently, yet little by little because sandy soil does not absorb water well.

In this study, areas which have humidity approximately 0.65 are studied but areas which have humidity such that 0.1 may be studied. We use the following solution for this problem.

Firstly, the selection of α, β, ω in $Z^{\omega}_{\alpha\beta}$ is made as follows in order to determine the value of the water requirements of the land.

Theorem 1. *The partial sum sequence of coefficients of n-th degree of $Z^{\omega}_{\alpha\beta}(A)$ is convergence.*

Proof.

$$\left(Z^{\omega}_{\alpha\beta}(A)\right)^n$$

$$= \left\{\left\langle x, \alpha^n\beta^n\mu(A) + \beta\omega(1-\alpha)\sum_{i=0}^{n-1}(\alpha\beta)^i, \alpha^n\beta^n\nu(A) + \alpha\omega(1-\beta)\sum_{i=0}^{n-1}(\alpha\beta)^i\right\rangle : x \in X\right\}$$

Let $a = \beta\omega(1-\alpha)$, $r = \alpha\beta$. Then sequentially we obtain

$S_k = a\sum_{i=0}^{k} r^i = a + ar + ... + ar^k$

$rS_k = ar + ar^2 + ... + ar^{k+1}$

$S_k = a\dfrac{1-r^{k+1}}{1-r}$

$S_{n-1} = a\dfrac{1-r^n}{1-r}$

Therefore, for S_{n-1} we obtain $\dfrac{a}{1-r} = \dfrac{\beta\omega(1-\alpha)}{1-\alpha\beta}$. For non-membership obtained in the same way: $\dfrac{\alpha\omega(1-\beta)}{1-\alpha\beta}$. □

Remark 1. *For the coefficient of required humidity (*rh*) of agricultural area, which is related to the type of soil and plants, the level of humidity of area is calculated as below:*

- $\dfrac{\beta\omega(1-\alpha)}{1-\alpha\beta}$ *is the membership degree of* $\left(Z^{\omega}_{\alpha\beta}(A)\right)^n$*;*
- $\dfrac{\alpha\omega(1-\beta)}{1-\alpha\beta}$ *is the non-membership degree of* $\left(Z^{\omega}_{\alpha\beta}(A)\right)^n$;
- *rh* $= \dfrac{1+\beta\omega-2\alpha\beta}{2(1-\alpha\beta)}$

Example 1. *Let X be an agricultural area. Variable α in $Z^{\omega}_{\alpha\beta}$ represents the type of soil and $|\beta-\omega|$ represents the water requirement, that is, if $|\beta-\omega|$ is low then the water requirement of plant is low and if $|\beta-\omega|$ is high the water requirement of plant is high.*

Example 2. *For $Z^{\omega}_{\alpha,\beta}$, let $\alpha = 0.1, \beta = 0.9, \omega = 0.9$. For this area, the following* rh *is calculated. It can be easily seen on Graph 4. By the help of theorem, we obtain:*

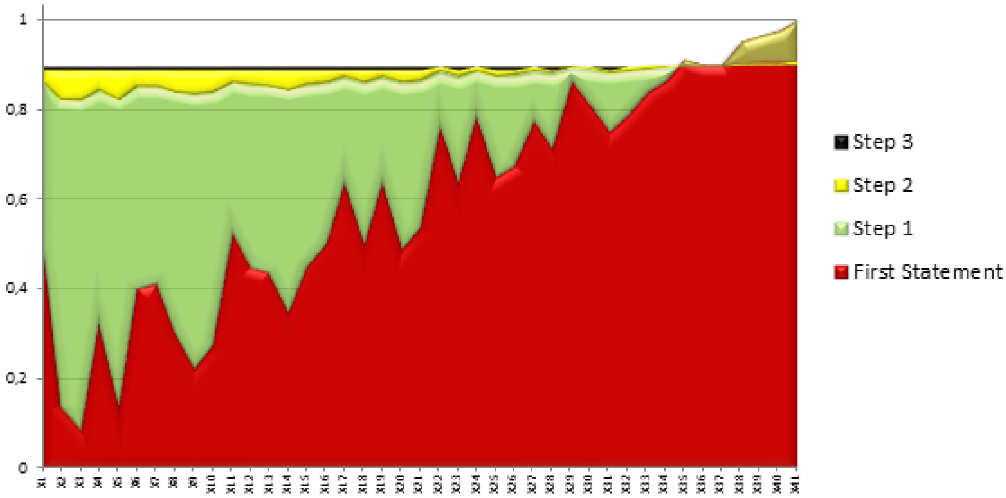
$$\frac{\beta\omega(1-\alpha)}{1-\alpha\beta} = \frac{0.9\times0.9(1-0.1)}{1-(0.1\times0.9)} = \frac{0.81\times0.9}{1-0.09} = \frac{0.729}{0.91} = 0.801098$$

which is close to the membership degree

$$\frac{\alpha\omega(1-\beta)}{1-\alpha\beta} = \frac{0.1\times0.9(1-0.9)}{1-(0.1\times0.9)} = \frac{0.09\times0.1}{1-0.09} = \frac{0.009}{0.91} = 0.009801$$

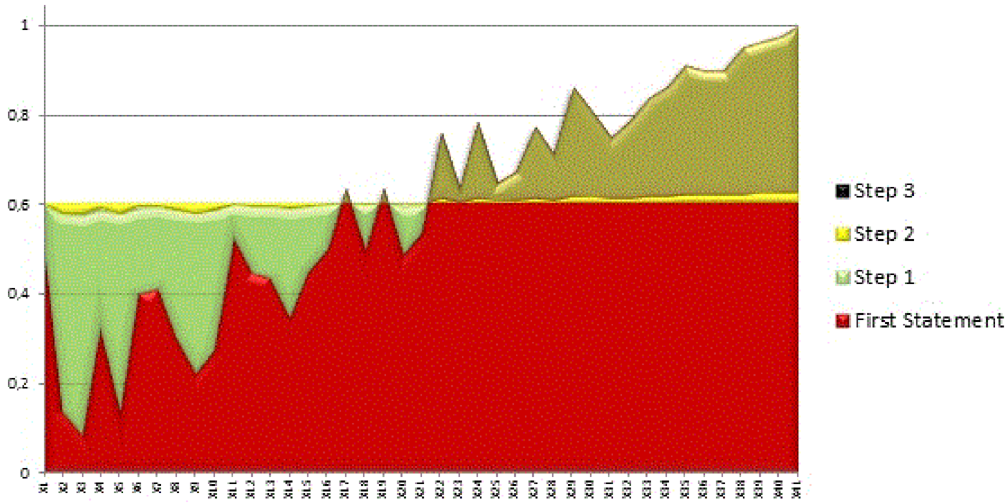
which is close to the non-membership degree

$$\text{rh} = \frac{1+\beta\omega-2\alpha\beta}{2(1-\alpha\beta)} = \frac{0.801098+0.990199}{2} = 0.8956485$$



Graph 4

The following graph examined for humus soil. It is obtained that a field has suitable humidity as calculated by $Z^{\omega}_{\alpha\beta}$ operator in Table 1. We get the values of α, β, ω respectively 0.1, 0.5 and 0.5 for the $Z^{\omega}_{\alpha\beta}$ operator.



Graph 5

As it is seen from the Graph 5, land irrigation is shown in 3 steps. Land is irrigated very fastly in the first step. Then in other steps, the speed of irrigation becomes increasingly slower.

In Table 2, we find the suitable humidity of sandy soil by using $Z^{\omega}_{\alpha\beta}(A)$.

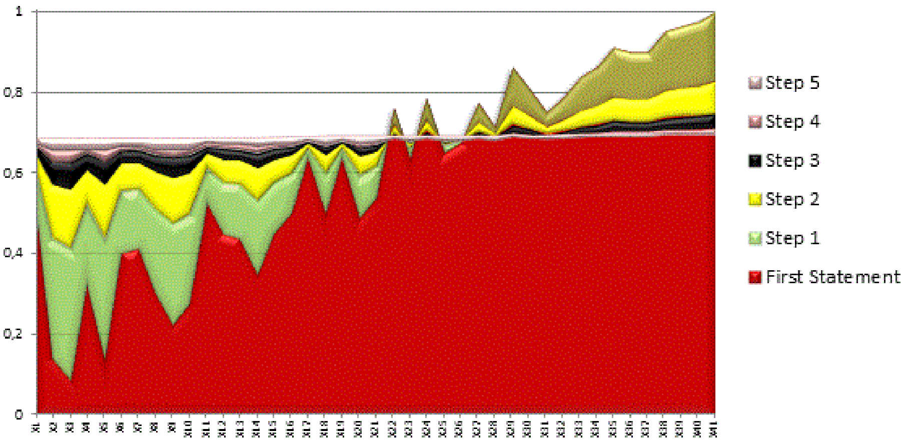
Example 3. *The following Graph 6 examines for sandy soil. Sandy soil does not absorb water well; therefore, the more steps apply the more amount of water absorbs. For this reason, we use five steps for sandy soil. In $Z^{\omega}_{\alpha\beta}$ operator the parameters have values $\alpha = 0.5$, $\beta = 0.9$, $\omega = 0.5$ for sandy soil. Water absorption gradually decreases, so water with which plants are irrigated, decreases. Thus, we provide the required humidity in an economical way.*

	μ	ν	MDZ 0,1 0,5 0,5	NDZ 0,1 0,5 0,5	Step1 ave-rage	MDZ 0,1 0,5 0,5	NDZ 0,1 0,5 0,5	Step2 average	MDZ 0,1 0,5 0,5	NDZ 0,1 0,5 0,5	Step3 average	MDZ 0,1 0,5 0,5	NDZ 0,1 0,5 0,5	Step4 average	MDZ 0,1 0,5 0,5	NDZ 0,1 0,5 0,5	Step4 average
X_{1}	0	0	0,225	0,025	0,1	0,23625	0,02625	0,005	0,236813	0,026313	0,00025	0,236841	0,026316	0,0000125	0,236842031	0,025	0,000659
X_{2}	0,03	0,75	0,2263	0,0625	0,444	0,236313	0,028125	0,022219	0,236816	0,026406	0,0011109	0,236841	0,02632	0,0000555	0,236842039	0,025	0,000661
X_{3}	0,05	0,875	0,2275	0,0688	0,492	0,236375	0,028438	0,024594	0,236819	0,026422	0,0012297	0,236841	0,026321	0,00006148	0,236842047	0,025	0,000661
X_{4}	0,08	0,425	0,2288	0,0463	0,266	0,236438	0,027313	0,013313	0,236822	0,026366	0,0006656	0,236841	0,026318	0,000033281	0,236842055	0,025	0,00066
X_{5}	0,1	0,825	0,23	0,0663	0,444	0,2365	0,028313	0,022219	0,236825	0,026416	0,0011109	0,236841	0,026321	0,000055547	0,236842063	0,025	0,000661
x_{6}	0,13	0,325	0,2313	0,0413	0,195	0,236563	0,027063	0,00975	0,236828	0,026353	0,0004875	0,236841	0,026318	0,000024375	0,23684207	0,025	0,000659
X_{7}	0,15	0,325	0,2325	0,0413	0,183	0,236625	0,027063	0,009156	0,236831	0,026353	0,0004578	0,236842	0,026318	0,00002289	0,236842078	0,025	0,000659
X_{8}	0,18	0,57	0,2338	0,0535	0,288	0,236688	0,027675	0,014381	0,236834	0,026384	0,0007191	0,236842	0,026319	0,000035953	0,236842086	0,025	0,00066
X_{9}	0,2	0,75	0,235	0,0625	0,361	0,23675	0,028125	0,018063	0,236838	0,026406	0,0009031	0,236842	0,02632	0,000045156	0,236842094	0,025	0,00066
X_{10}	0,23	0,675	0,2363	0,0588	0,314	0,236813	0,027938	0,015688	0,236841	0,026397	0,0007844	0,236842	0,02632	0,000039298	0,236842102	0,025	0,00066
X_{11}	0,25	0,2	0,2375	0,035	0,076	0,236875	0,02675	0,003813	0,236844	0,026338	0,0001906	0,236842	0,026317	0,000095312	0,236842109	0,025	0,000658
X_{12}	0,28	0,375	0,2388	0,0438	0,148	0,236938	0,027188	0,007375	0,236847	0,026359	0,0003687	0,236842	0,026318	0,000018437	0,236842117	0,025	0,000659
X_{13}	0,3	0,425	0,24	0,0463	0,159	0,237	0,027313	0,007969	0,23685	0,026366	0,0003984	0,236843	0,026318	0,000019921	0,236842125	0,025	0,000659
X_{14}	0,33	0,625	0,2413	0,0563	0,243	0,237063	0,027813	0,012125	0,236853	0,026391	0,0006063	0,236843	0,02632	0,000030312	0,236842133	0,025	0,00066
X_{15}	0,35	0,45	0,2425	0,0475	0,148	0,237125	0,027375	0,007375	0,236856	0,026369	0,0003688	0,236843	0,026318	0,000018437	0,236842141	0,025	0,000659
X_{16}	0,38	0,375	0,2438	0,0438	0,1	0,237188	0,027188	0,005	0,236859	0,026359	0,00025	0,236843	0,026318	0,0000125	0,236842148	0,025	0,000659
X_{17}	0,4	0,125	0,245	0,0313	-0,03	0,23725	0,026563	-0,00153	0,236863	0,026328	0,000077	0,236843	0,026316	-0,000038281	0,236842156	0,025	0,000658
X_{18}	0,43	0,425	0,2463	0,0463	0,1	0,237313	0,027313	0,005	0,236866	0,026366	0,00025	0,236843	0,026318	0,0000125	0,236842164	0,025	0,000659
X_{19}	0,45	0,175	0,2475	0,0338	-0,03	0,237375	0,026688	-0,00153	0,236869	0,026334	0,000077	0,236843	0,026317	-0,000038281	0,236842172	0,025	0,000658
X_{20}	0,48	0,5	0,2488	0,05	0,112	0,237438	0,0275	0,005594	0,236872	0,026375	0,0002797	0,236844	0,026319	0,000013984	0,23684218	0,025	0,000659
X_{21}	0,5	0,425	0,25	0,0463	0,064	0,2375	0,027313	0,003219	0,236875	0,026366	0,0001609	0,236844	0,026318	0,000008047	0,236842188	0,025	0,000658
X_{22}	0,53	0	0,2513	0,025	-0,15	0,237563	0,02625	-0,00747	0,236878	0,026313	-0,000373	0,236844	0,026316	-0,000018671	0,236842195	0,025	0,000657
X_{23}	0,55	0,275	0,2525	0,0388	-0,03	0,237625	0,026938	-0,00153	0,236881	0,026347	-0,000077	0,236844	0,026317	-0,000038186	0,236842203	0,025	0,000658
X_{24}	0,58	0	0,2538	0,025	-0,17	0,237688	0,02625	-0,00866	0,236884	0,026313	-0,000433	0,236844	0,026316	-0,00002164	0,236842211	0,025	0,000657
X_{25}	0,6	0,3	0,255	0,04	-0,04	0,23775	0,027	-0,00213	0,236888	0,02635	-0,000106	0,236844	0,026318	-0,000053125	0,236842219	0,025	0,000658
X_{26}	0,63	0,275	0,2563	0,0388	-0,07	0,237813	0,026938	-0,00331	0,236891	0,026347	-0,000166	0,236845	0,026317	-0,000082	0,236842227	0,025	0,000658
X_{27}	0,65	0,1	0,2575	0,03	-0,16	0,237875	0,0265	-0,00806	0,236894	0,026325	-0,000403	0,236845	0,026316	-0,00002015	0,236842234	0,025	0,000657
X_{28}	0,68	0,25	0,2588	0,0375	-0,1	0,237938	0,026875	-0,00509	0,236897	0,026344	-0,000255	0,236845	0,026317	-0,00001273	0,236842242	0,025	0,000657
X_{29}	0,83	0,1	0,2663	0,03	-0,24	0,238313	0,0265	-0,01222	0,236916	0,026325	-0,000611	0,236846	0,026316	-0,0000305	0,236842289	0,025	0,000656
X_{30}	0,73	0,1	0,2613	0,03	-0,2	0,238063	0,0265	-0,00984	0,236903	0,026325	-0,000492	0,236845	0,026316	-0,000024609	0,236842258	0,025	0,000657
X_{31}	0,75	0,25	0,2625	0,0375	-0,14	0,238125	0,026875	-0,00687	0,236906	0,026344	-0,000344	0,236845	0,026317	-0,0000171	0,236842266	0,025	0,000657
X_{32}	0,78	0,2	0,2638	0,035	-0,17	0,238188	0,02675	-0,00866	0,236909	0,026338	-0,000433	0,236845	0,026317	-0,00002164	0,236842273	0,025	0,000657
X_{33}	0,8	0,125	0,265	0,0313	-0,22	0,23825	0,026563	-0,01103	0,236913	0,026328	-0,000552	0,236846	0,026316	-0,0000275	0,236842281	0,025	0,000657
X_{34}	0,83	0,1	0,2663	0,03	-0,24	0,238313	0,0265	-0,01222	0,236916	0,026325	-0,000611	0,236846	0,026316	-0,000030546	0,236842289	0,025	0,000656
X_{35}	0,85	0,025	0,2675	0,0263	-0,29	0,238375	0,026313	-0,01459	0,236919	0,026316	-0,00073	0,236846	0,026316	-0,0000364	0,236842297	0,025	0,000656
X_{36}	0,88	0,075	0,2688	0,0288	-0,28	0,238438	0,026438	-0,014	0,236922	0,026322	-0,0007	0,236846	0,026316	-0,000035	0,236842305	0,025	0,000656
X_{37}	0,9	0,1	0,27	0,03	-0,28	0,2385	0,0265	-0,014	0,236925	0,026325	-0,0007	0,236846	0,026316	-0,000035	0,236842313	0,025	0,000656
X_{38}	0,93	0,025	0,2713	0,0263	-0,33	0,238563	0,026313	-0,01638	0,236928	0,026316	-0,000819	0,236846	0,026316	-0,000040937	0,23684232	0,025	0,000656
X_{39}	0,95	0,025	0,2725	0,0263	-0,34	0,238625	0,026313	-0,01697	0,236931	0,026316	-0,000848	0,236847	0,026316	-0,00004242	0,236842328	0,025	0,000656
X_{40}	0,98	0,02	0,2738	0,026	-0,35	0,238688	0,0263	-0,01768	0,236934	0,026315	-0,000884	0,236847	0,026316	-0,0000442	0,236842336	0,025	0,000656
X_{41}	1	0	0,275	0,025	-0,38	0,23875	0,02625	-0,01875	0,236938	0,026313	-0,000938	0,236847	0,026316	-0,000046875	0,236842344	0,025	0,000656

Table 1

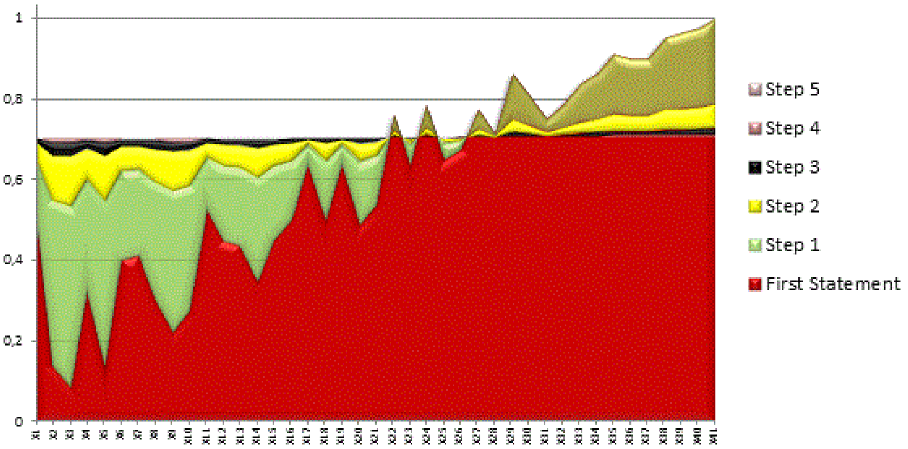
	μ	v	Step1 avarege	Step2 avarege	Step3 avarege	Step4 avarege	Step5 avarege
X_1	0	0	0,1	0,045	0,02025	0,009112	0,013909
X_2	0,03	0,75	0,299375	0,134719	0,060623	0,027281	0,029004
X_3	0,05	0,875	0,326875	0,147094	0,066192	0,029786	0,031285
X_4	0,08	0,425	0,19625	0,088313	0,039741	0,017883	0,021777
X_5	0,1	0,825	0,299375	0,134719	0,060623	0,027281	0,029696
X_6	0,13	0,325	0,155	0,06975	0,031388	0,014124	0,019162
X_7	0,15	0,325	0,148125	0,066656	0,029995	0,013498	0,018881
X_8	0,18	0,57	0,208625	0,093881	0,042247	0,019011	0,023622
X_9	0,2	0,75	0,25125	0,113063	0,050878	0,022895	0,027031
X_9	0,23	0,675	0,22375	0,100688	0,045309	0,020389	0,025211
X_{11}	0,25	0,2	0,08625	0,038813	0,017466	0,00786	0,01519
X_{12}	0,28	0,375	0,1275	0,057375	0,025819	0,011618	0,018496
X_{13}	0,3	0,425	0,134375	0,060469	0,027211	0,012245	0,019239
X_{14}	0,33	0,625	0,1825	0,082125	0,036956	0,01663	0,023058
X_{15}	0,35	0,45	0,1275	0,057375	0,025819	0,011618	0,019188
X_{16}	0,38	0,375	0,1	0,045	0,02025	0,009113	0,017368
X_{17}	0,4	0,125	0,024375	0,010969	0,004936	0,002221	0,011961
X_{18}	0,43	0,425	0,1	0,045	0,02025	0,009113	0,01783
X_{19}	0,45	0,175	0,024375	0,010969	0,004936	0,002221	0,012422
X_{20}	0,48	0,5	0,106875	0,048094	0,021642	0,009739	0,018804
X_{21}	0,5	0,425	0,079375	0,035719	0,016073	0,007233	0,016984
X_{22}	0,53	0	-0,044375	-0,01997	-0,00899	-0,00404	0,007988
X_{23}	0,55	0,275	0,024375	0,010969	0,004936	0,002221	0,013345
X_{24}	0,58	0	-0,058125	-0,02616	-0,01177	-0,0053	0,007424
X_{25}	0,6	0,3	0,0175	0,007875	0,003544	0,001595	0,013293
X_{26}	0,63	0,275	0,00375	0,001688	0,000759	0,000342	0,012499
X_{27}	0,65	0,1	-0,05125	-0,02306	-0,01038	-0,00467	0,008629
X_{28}	0,68	0,25	-0,016875	-0,00759	-0,00342	-0,00154	0,011423
X_{29}	0,83	0,1	-0,099375	-0,04472	-0,02012	-0,00906	0,006656
X_{30}	0,73	0,1	-0,071875	-0,03234	-0,01455	-0,00655	0,007783
X_{31}	0,75	0,25	-0,0375	-0,01688	-0,00759	-0,00342	0,010577
X_{32}	0,78	0,2	-0,058125	-0,02616	-0,01177	-0,0053	0,00927
X_{33}	0,8	0,125	-0,085625	-0,03853	-0,01734	-0,0078	0,00745
X_{34}	0,83	0,1	-0,099375	-0,04472	-0,02012	-0,00906	0,006656
X_{35}	0,85	0,025	-0,126875	-0,05709	-0,02569	-0,01156	0,004836
X_{36}	0,88	0,075	-0,12	-0,054	-0,0243	-0,01094	0,005579
X_{37}	0,9	0,1	-0,12	-0,054	-0,0243	-0,01094	0,00581
X_{38}	0,93	0,025	-0,1475	-0,06638	-0,02987	-0,01344	0,00399
X_{39}	0,95	0,025	-0,154375	-0,06947	-0,03126	-0,01407	0,003708
X_{40}	0,98	0,02	-0,162625	-0,07318	-0,03293	-0,01482	0,003324
X_{41}	1	0	-0,175	-0,07875	-0,03544	-0,01595	0,002632

Table 2



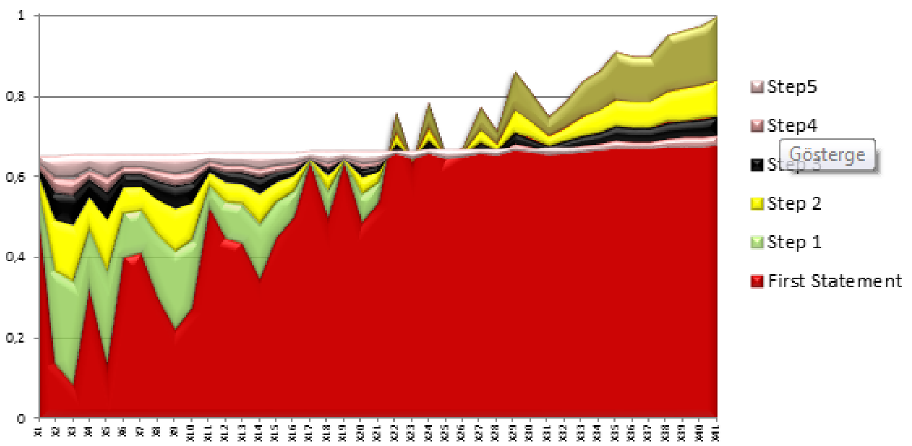
Graph 6

Example 4. *For marl soil; if we choose* $\alpha = 0.3$, $\beta = 0.9$, $\omega = 0.5$, *then we obtain the result from Graph 7.*



Graph 7

Example 5. *For loamy soil, if we choose* $\alpha = 0.6$, $\beta = 0.9$, $\omega = 0.45$, *then we obtain the result from Graph 8.*



Graph 8

In the different cases of critical levels of moisture that soil needs for every domains, we can separate the domains with respect to the temperature, the slope of the terrain, soil moisture and air humidity. In the general case, we suppose that the farmland has afforestation consisting of the same type of trees. By analogy with [5], instead of using operator $E_{\alpha\beta}$, by using the operator $Z^{\omega}_{\alpha\beta}$ the problems of temperature, slope, soil moisture and air humidity related to the farmland systems may be resolved in similar manner. Thus the presented system paves the way for farmers to utilize less water for irrigation in a more economical way, compared to traditional methods in agricutlure.

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