

## Design a Multi Objective Optimization Model to Determination of Optimal Cultivation Pattern Influenced Climate Change Phenomenon (Case Study: Birjand Plain)

AHMAD JAFARZADEH<sup>1\*</sup>, ABBAS KHASHEI-SIUKI<sup>2</sup>, ALI SHAHIDI<sup>3</sup>

1. Master Student, Faculty of Agriculture, University of Birjand
  2. Assistant Professor, Faculty of Agriculture, University of Birjand
  3. Associate Professor, Faculty of Agriculture, University of Birjand
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### ABSTRACT

Limitation of Production Main resources such as water, allocation of this resources has a high importance. To province of surface and groundwater resources perish and also raise of farmers business prosperity, apply scenarios which based on cultivation pattern mid water resource protection are necessary. In this situation select method which can simulate several aims and guide managers for select best method is very important. One of these methods is using of multiobjective metaheuristic algorithms. In this study for determine optimal cultivation pattern on 2039, raise of farmers income and lessen groundwater headless in aquifer influenced climate change effects selected as fitness function. Also for reach to this aim used of multi objective particle swarm optimization algorithm (MOPSO). for simulation of climate parameters used of BCM2 outputs model under B1 emission scenario. Results and discoveries of this study showed that there is needful potentials for reach to better situation proportion now, as cultivation pattern optimal values for plant and garden crops can moreover raise of total income saling crops, aids to lessen groundwater headless in aquifer. Results showed that Raise of area in crops such as saffron, jujube and barnerry as agriculture potential in cultivation pattern moreover of lesson of groundwater headless can also obtain economic development. Also results showed maximum of average benefit per average cost all crops in minimum groundwater headless equal with 3.86. also value of groundwater headloss in this situation equal with 26.9 centimeter per year.

**Keywords:** Groundwater, Multiobjective, Benefit Per Cost, MOPSO

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\* Correspondent author's E-mail: mnt.jafarzadeh@chmail.ir

## Optimization of Diversion Dam Section Based on Genetic Algorithm

SAMIRA YOUSEFI<sup>1</sup>, MOHAMMAD MEHDI HEIDARI<sup>2\*</sup>, MOHAMMAD HOSSAIN ADIB RAD<sup>3</sup>

1. Former M.Sc. student, Department of Water Engineering, College of Agriculture and Natural Resources, Razi University, Iran

2. Assistant Professor, College of Agriculture and Natural Resources, Razi University

3. Assistant Professor, College of Agriculture and Natural Resources, Razi University

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### ABSTRACT

Diversion dams is designed in order to raise the water level of river and to convey water into the main canal of irrigation network. If the dimensions of different parts of the diversion dam are considered large, it will be stable, but due to the increase volume of materials, construction costs will be high. Design engineer must choose dimensions of dam having least amount of materials and also is stable. Optimum dimensions of diversion dams can be calculated by classic and genetic algorithm methods. The purpose of this study was to present computer model based on genetic algorithm for optimal designing of dimensions of diversion dams consuming the least volume of materials in spite of regarding design rules. Decision variables used in the study included wall height of upstream and downstream of dam, body slope in upstream, thickness of stilling basin, length and thickness of concrete blanket upstream of dam. The objective function is to minimize amount of materials used. Design constraints include regarding dam stability safety factors against Piping, sliding, overturning and failure. In the research, firstly, optimizing program of diversion dam section was prepared using genetic algorithm in visual basic, and then Nazelian dam section was compared to re-designed model with conducted section. Results showed that if genetic algorithm was used for designing Nazelian dam for legal overturning coefficient about 2.1, volume of materials will be reduced by 15.4% and more economically designed. Suitable values for the number of generation, population size, probability crossover and mutation to optimize Diversion Dam were 100, 30, 0.55 and 0.05, respectively.

**Keywords:** Nazelian Dam; Stability safety factors; Penalty function; Genetic parameters

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\* Correspondent author's E-mail: mm.heidari@razi.ac.ir

## Estimation of Soil Hydraulic Parameters Using Double-Ring Infiltrometer Data *via* Inverse Method

PARISA MASHAYEKHI<sup>1</sup>, SHOJA GHORBANI DASHTAKI<sup>2\*</sup>, MOHAMMAD REZA MOSADDEGHI<sup>3</sup>, HOSSEIN SHIRANI<sup>4</sup>, MEHDI PANAHI<sup>5</sup>, MOHAMMAD REZA NOURI<sup>6</sup>

1. PhD student, Department of Soil Science, College of Agriculture, University of Shahrekord, Shahrekord.
2. Associate Professor, Department of Soil Science, College of Agriculture, University of Shahrekord, Shahrekord.
3. Associate Professor, Department of Soil Science, College of Agriculture, Isfahan University of Technology, Isfahan.
4. Associate Professor, Department of Soil Science, College of Agriculture, Vali-e-Asr University, Rafsanjan.
5. Assistant Professor, Department of irrigation and soil physics, Soil and Water Research Institute,
6. Associate Professor, Department of Irrigation Engineering, College of Agriculture, University of Shahrekord,

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### ABSTRACT

HYDRUS2D/3D software was employed to estimate the hydraulic parameters of van Genuchten-Mualem model *via* inverse modeling using double-ring infiltrometer's data (within 3 different soil textures). Nine scenarios of inverse modeling (divided in three groups) were considered with different numbers (5, 4 and 3) of fitted hydraulic parameters for optimization. In the first group, simulation was carried out solely using cumulative infiltration data. As for the second group, cumulative infiltration data plus water content at  $h = -330$  cm (Field Capacity, FC) were taken as inputs. In the third group, cumulative infiltration data plus water contents at  $h = -330$  cm (FC) and  $h = -15000$  cm (Permanent Wilting Point, PWP) were simultaneously taken as predictors. The results indicated that by reducing the number of hydraulic parameters, involved in the optimization process, simulation error would be reduced and the accuracy of prediction of other soil hydraulic parameters enhanced. Including FC as an additional data was important to more accurately optimize/define soil hydraulic functions. So, the use of (Saturated hydraulic conductivity)  $K_s$ , (Shape parameter of soil water characteristic curve)  $n$  and (the parameter, inversely related to the air entry value)  $a$ , as predictor parameters and FC as additional data constituted the most appropriate scenario. RMSE(cm<sup>3</sup>), NRMSE, AIC, and  $R^2$  were respectively estimated 1259, 528.2, 0.0081 and 0.9999 in Sandy Loam soil, 242, 79.0, 0.0059 and 0.9988 in Loamy soil plus 298, 153.6, 0.0174 and 0.9983 in Salty Clay soil. Taking into account PWP as additional data increased the simulation error in all the 3 soil textures.

**Key words:** HYDRUS software, Numerical solution, Saturated Infiltration, Van Genuchten–Mualem model

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\* Correspondent author's E-mail: Shoja2002@yahoo.com

## Interaction of Water and Nitrogen on the Yield and Water Use Efficiency in Maize Using Elasticity Theory

FARZANEH SHOARI AZADI<sup>1</sup>, ALI RAHIMIKHOOB<sup>2\*</sup>, MAJID GHORBANIJAVID<sup>3</sup>, MOHAMMAD HADI NAZARIFAR<sup>4</sup>

1. Graduate Student, Department of Irrigation and Drainage Engineering, Aburaihan College, University of Tehran

2. Professor, Department of Irrigation and drainage Engineering, Aburaihan College, University of Tehran

3. Assistant Professor, Department of Crop Science and Plant Breeding, Aburaihan College, University of Tehran

4. Research Expert, Department of Crop Science and Plant Breeding, Aburaihan College, University of Tehran

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### ABSTRACT

Water and nitrogen fertilizer are two of the main input factors in agricultural production, the deficiency of each one of which causes reduction in the crop yield. Deficit irrigation is one of the ways for improvement of water management in arid and semiarid areas; meanwhile it affects the need for nitrogen. Excessive use of nitrogen will lead to a waste of capital and also environmental pollution. Throughout the present study the effect of the interaction of water and nitrogen fertilizer on maximum crop yield and maximum water productivity in maize was investigated using elasticity analysis theory. The tests were carried out during the summer of 1393 on the research farm of Aboureihan Pardis located in Pakdasht in the South East of Tehran. A split plot randomized complete block design of four treatments for water and four treatments for nitrogen fertilizer (in three replications) was employed. The maximum yield with no deficit irrigation and maximum water use efficiency were obtained, using the equations of the theory of elasticity. Results indicated that a maximum yield of 27467 kg ha<sup>-1</sup> and 300 kg N ha<sup>-1</sup> were achieved with 1011 mm of water and water use efficiency being estimated at 2.75 kg per cubic meter. A maximum water use efficiency of 3.02 kg m<sup>-3</sup> was obtained when with 87% water deficit and 375 N per hectare.

**Keywords:** deficit irrigation, fertilizer, Economy, Water-plant relationship, yield function

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\* Correspondent author's E-mail: akhob@ut.ac.ir

## Geochemical Properties of Some Soils Developed on Basalt Rocks of North-West Iran

ALIREZA RAHEB<sup>1</sup>, AHMAD HEIDARI<sup>2\*</sup>, SHAHLA MAHMOODI<sup>3</sup>

1. Ph.D. student, Faculty of Agricultural Engineering and Technology, College of Agriculture & Natural Resources, University of Tehran

2. Associate Professor, Faculty of Agricultural Engineering and Technology College of Agriculture & Natural Resources, University of Tehran

3. Professor, Faculty of Agricultural Engineering and Technology College of Agriculture & Natural Resources, University of Tehran

(Accepted: Mar. 2, 2016- Received: Jun. 6, 2016)

### ABSTRACT

Soil genesis and evolution studies are based on well understanding of geochemical processes involved in pedogenic processes and formation of soil. In this study, physicochemical and geochemical properties of 6 selected soil profiles developed on basalt rocks along arid (Eshtehard), semiarid (Qazvin) and semi humid (Roodbar) climosequence representing three different climatic zones were investigated. The total content of some elements of all soil horizons were compared to parent rocks to reveal the role geochemical composition of rock on total concentrations of these elements in soil. Enrichment/depletion patterns and mass-balance calculations of elements were assessed using Ti as reference element. The studied elements exhibited different enrichment/depletion patterns. In soils of arid region, the role of parent material and lithogenic properties in concentration of elements were greater than other areas and the content of these elements due to lower weathering and leaching were closer to the parent rock. While, in more humid climates pedogenic processes were more intensive and enrichment/depletion patterns of elements showed states that are more progressive. Distribution of some studied elements such as magnesium, calcium, iron and copper were significantly affected by soil forming process and the parent material affected some other elements such as sodium, aluminum, silicon, phosphorus, chlorine, manganese, molybdenum, cadmium and lead. In general, part of the difference in the concentrations of elements can be related to their chemical nature and the mobility of some elements, and some part to rapid weathering of parent materials affected by bioclimatological changes.

**Keywords:** Arid climate, Enrichment factor, Pedogenic processes, Pedogenic factors, Soil genesis.

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\* Correspondent author's E-mail: ahaidari@ut.ac.ir

## Improvement of Water Infiltration in an Erosion-Prone Soil under Laboratory Conditions and through Artificial Increase of Soil Microorganisms' Population

SEYED HAMIDREZA SADEGHI<sup>1\*</sup>, HOSSEIN KHEIRFAM<sup>2</sup>, MEHDI HOMAEI<sup>3</sup>, BEHROUZ ZAREI DARKI<sup>4</sup>

1. Professor, Faculty of Natural Resources, Tarbiat Modares University.

2. PhD Candidate, Faculty of Natural Resources, Tarbiat Modares University.

3. Professor, Faculty of Agriculture, Tarbiat Modares University.

4. Assistant Professor, Faculty of Marine Science, Tarbiat Modares University

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### ABSTRACT

Runoff production process is a key hydrological component illustrating watersheds' well-being health. Water infiltration in soil is also one of the determinant factors of runoff generation for improvement of which many techniques have been employed. However, the role of microorganisms for the improvement of water infiltration in soils has been considered to a lesser extent. Within the present study therefore, it was tried to investigate the effect of artificial soil bacteria population proliferation as a completely biological and modern technique to improve soil surface properties and consequently to increase soil infiltration. To this end, the promising bacteria, namely *Bacillus subtilis* strain and *Azotobacter* sp. were isolated and inoculated individually as well as combined with B4 stimulant nutrient matter to small erosion plots, filled with an erosion-prone soil of Marzanabad-Kandelus road neighboring region, then left for 60 days. The water infiltration in soil was later on recorded after rainfall simulation within experimental conditions after which statistical analyses were conducted. The results revealed that the inoculation treatments (inoculation of *Bacillus subtilis* strain and *Azotobacter* sp., individually injected with B4 stimulant nutrient matter as well as combined inoculation of bacteria and B4 stimulant nutrient matter) improved the water infiltration in soil and reduced volume and consequently coefficient of runoff within 99% of confidence level as compared with control. Water infiltration in soil in *Bacillus subtilis* strain and *Azotobacter* sp. bacteria inoculation, B4 stimulant nutrient matter and their combined treatments increased about 18, 10 and 21%, respectively. In conclusion, enrichment of soil crust bacteria population through inoculation and stimulation techniques was approved in reducing runoff yield. The combined inoculation of *Bacillus subtilis* strain and *Azotobacter* sp. bacteria with B4 stimulant nutrient matter presented the most acceptable performance in increasing water infiltration in the studied soil.

**Keywords:** Bio-amendments, Ecohydrology, Land Degradation, Soil and Water Conservation.

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\* Correspondent author's E-mail: sadeghi@modares.ac.ir

## Norms Establishment of the Diagnosis and Recommendation Integrated System (DRIS) for Nutritional Diagnosis of Onion (*Allium cepa L*) in Western Azarbaijan Province, Iran

MINA FEIZI<sup>1\*</sup> AND ABBAS SAMADI<sup>2</sup>

1. Senior Expert, Faculty of Agriculture, Urmia University

2. Professor, Faculty of Agriculture, Urmia University

Email: azarkhaklab@yahoo.com

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### ABSTRACT

Diagnosis and Recommendation Integrated System (DRIS) can be employed as an efficient method of interpreting the results of plant analysis and the nutritional diagnosis in crops, as well as in fruit trees. To establish DRIS norms in onion (*Allium cepa L*) leaf samples were collected from 50 fields and N, P, K, Ca, Mg, Fe, Mn, Zn, Cu and B concentrations determined. On the bases of yield, the studied fields were divided into two groups of low vs. high yield. DRIS norms were established for the different nutrient ratios. DRIS indices were determined to evaluate nutrients' balance and the order of nutrient requirements. On the basis of means of DRIS indexes, the respective ranks for the requirement of nutrients were determined as Ca>K>P>Mg>N for macro nutrients vs. Cu>Mn>B>Zn>Fe for micro nutrients. Sufficiency ranges of macro as well as micro nutrients were also derived through DRIS technique. DRIS-derived sufficiency ranges were recorded as 2.9-3.68, 0.21-0.39, 3.7-6.4, 1.38-2.6, 0.23-0.33 % for N, P, N, Ca, Mg, and 86-154, 9-32, 44-65, 9-18, 23-35 mg/kg for Fe, Zn, Mn, Cu, B respectively. The Nutrient Balance Index (NBI) of DRIS amounted to much more than zero in all the low-yielding farms.

**Keywords:** Nutrient Balance Index, Plant analysis, Sufficiency range.

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\* Correspondent author's E-mail: azarkhaklab@yahoo.com

## Quantitative Soil Quality Assessment in Different Land Uses at Some Parts of South Eastern of Qazvin

MANOUCHEHR GORJI<sup>1</sup>, JALIL KAKEH<sup>2\*</sup>, ALIREZA ALIMOHAMADI<sup>3</sup>

1. Associate professor of Soil Sciences Department, University of Tehran

2. PhD student of Soil Sciences Department, University of Tehran

3. MSc student of Soil Sciences Department, University of Tehran

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### ABSTRACT

Assessment of soil quality is one of the most useful tools for evaluation the soil management condition and different land uses. Quantity indices of soil quality are most suitable methods for determination and comparison of soils quality. In this study soil quality indices and selection methods of effective soil properties were compared for evaluating the soil quality in different land uses. Seventeen soil physical, chemical and biological properties were selected as total data set (TDS) at five different land uses including orchard, rangeland, irrigated farming, dry land farming and unutilized lands, in slope classes of 0-2, 5-7, and 9-11 %, at some parts of south eastern of Qazvin (Iran). Then, 7 properties selected as minimum data set (MDS) using Principle Component Analysis (PCA). Soil quality was evaluated by integrated quality index (IQI) and nemero quality index (NQI) in two set of soil properties including MDS and TDS. The results showed that orchard and rangeland had the highest IQI and NQI in both data sets, respectively, however irrigated farming, dry land farming and unutilized lands have the least IQI and NQI in both data sets, respectively and have significant different compared to orchard and rangeland. Correlation coefficient between TDS and MDS was 0.95 and 0.88 for IQI and NQI, respectively, indicating the reliability of the MDS instead of TDS, and showed that the IQI offers better results for evaluating the soil quality in this case study.

**Keywords:** Integrated quality index, Nemero quality index, Total data set, Minimum data set, land use.

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\* Correspondent author's E-mail: Jalil.kaka@ut.ac.ir



## The Study of Nitrate Dispersivity in Sandy Soil Using HYDRUS-1D Model

ATEFEH AZADIFAR<sup>1\*</sup>, AMIR SOLTANI MOHAMMADI<sup>2</sup>, HADI MOAZED<sup>3</sup>, AHMAD FARROKHIAN FIROUZI<sup>4</sup>

1. M.Sc., Faculty of Water Science, Shahid Chamran University of Ahvaz

2. Professor, Faculty of Water Science, Shahid Chamran University of Ahvaz

3Assistant Professor, Faculty of Water Science, Shahid Chamran University of Ahvaz

3Assistant Professor, Faculty of Agriculture, Shahid Chamran University of Ahvaz

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### ABSTRACT

The increasing use of nitrogen fertilizers due to high dynamics of nitrate in the soil would be a serious threat to groundwater, and therefore, to human health. This study is aimed to investigate the dispersivity values of nitrate in the coarse, medium and fine sandy soils in the short travel distance of 20, 40 and 80 cm in vitro using the HYDRUS-1D model. For this purpose, pure potassium nitrate salt solution under the sustainable regime with concentration of 160 (mg/lit) was added to the soil columns as persistent contaminants, then for extracting the needed parameters the concentration of output nitrate in three different porosities volumes were measured and Breakthrough curves were plotted for each column. The results showed that dispersivity increases as the soil particle size increases. Also, by increasing the average travel distance in medium and coarse sands nitrate dispersivity values increased. But in the fine sand the dispersivity values decreased as the transmission distance increased. The dispersivity values for fine, medium and coarse sand were from 30/50 to 42/55 cm, 57/06 to 68/51 cm, and 68/50 to 97/06 cm, respectively. The average model error percent ( $E_r$ ) was less for fine sandy soil, and coefficient of determination ( $R^2$ ) was relatively more for fine sandy soil than the coarse and medium sandy soils, which means the lower error value and higher precision of the overall process in simulation of nitrate transfer in this model for the fine sandy soils.

**Keywords:** travel distance, Breakthrough curve, Sandy soil saturation, Pollutant Transfer

## Evaluate and develop new relationships to estimate submerged hydraulic jump characteristics

AMIN GHASSEMI<sup>1\*</sup>, MOHAMMAD HOSSEIN OMID<sup>2</sup>, MOHSEN NASRABADI<sup>3</sup>, ALI RAEISI ESTABRAGH<sup>4</sup>

1. M.Sc. Student, Irrigation and Reclamation Eng. Dept., University of Tehran

2. Professor, Irrigation and Reclamation Eng. Dept., University of Tehran

3. PhD Candidate, Irrigation and Reclamation Eng. Dept., University of Tehran

4. Associate Professor, Irrigation and Reclamation Eng. Dept., University of Tehran

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### Abstract

In this research, in order to develop new relationships with reasonable accuracy for estimation of the submerged hydraulic jump characteristics, a study has been conducted experimentally. Experiments have been done in a rectangular channel with a length of 9 m, a width of 0.5 m and a depth of 0.45 m. Froude numbers in these tests range from 3.5 to 11.5 and between submergence ratios of 0.1 to 4. According to the results, the water surfaces profiles have been obtained in different Froude numbers and submergence ratios. Also, some relationships with high accuracy to estimate such characteristics as jump length, submerged depth on the gate, and the relative energy loss have been developed. The results also showed that, in a given Froude number, length and relative energy loss for submerged hydraulic jump are, respectively, more and less than those for free hydraulic jumps. In addition, for submerged hydraulic jump, at a given Froude number, by increasing the submergence ratio, the jump length and submergence depth on the gate increases and relative energy loss decreases. Finally, using sensitivity analysis technique, the effectiveness of dominant parameters on the developed expressions on the changes in submergence depth on the gate parameters and relative energy loss has been determined.

**Keywords:** Submerged Hydraulic jump, Water surface profile, Submergence depth on the gate, Relative energy loss, Sensitivity analysis

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\* Correspondent author's E-mail: amin\_ghassemi@ut.ac.ir

## The Survey of Climate Change Impact on Drought Severity- Duration- Frequency Curves Using Copulas

MASOUDEH AZIZABADI FARAHANI<sup>1</sup>, BAHRAM BAKHTIARI<sup>2\*</sup>, KOUROSH QADERI<sup>3</sup>, MOHSEN REZAPOUR<sup>4</sup>

1. M. Sc. Graduate Student, Department of Water Engineering, Shahid Bahonar University of Kerman

2. Assistant Professor in the Department of Water Engineering, Shahid Bahonar University of Kerman

3. Assistant Professor in the Department of Water Engineering, Shahid Bahonar University of Kerman

4. Assistant Professor, Department of Statistics, Shahid Bahonar University of Kerman

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### ABSTRACT

Climate change has various effects on the quantity of rainfall and warming also is lead to increases in frequency and intensity of droughts by accelerating earth drying up and consequently. It is effective on the curves of severity- duration- frequency of drought (SDF). The purpose of this study is to evaluate the effects of climate change on SDF curves in the future in Qareh su basin located in the Golestan province. First, precipitation and temperature variables were generated using basin-areal average time series from years 1983-2012 and “CanESM2” model outputs as a general circulation model under the RCP 2.6, RCP 4.5 and RCP 8.5 scenarios and “SDSM” model as a statistical downscaling model over the period 2019-2048. Then SDF curves were derived from 3-month Reconnaissance Drought Index (RDI) and Copula approach and conditional return period in the base and future time periods. The results showed that monthly precipitation and temperature for the future time period under different scenarios are generally decreased and increased, respectively and the return period of a drought event with severity equal to 10 with respect to 6-month duration or less, is 5 years in the base period. The return periods of the same event under RCP 2.6, RCP 4.5 and RCP 8.5 are 21, 17 and 4 years, respectively.

**Keywords:** Golestan province, conditional return period, SDSM, drought Severity- Duration- Frequency

## Effects of Different Levels of Irrigation, Planting Density, Planting Pattern on Yield, Yield Components and Water Use Efficiency in Drip Irrigated Corn

PEYMAN AFRASIYAB<sup>1</sup>, MASOOME DELBARI<sup>2</sup>, HOSSEIN JAFARI<sup>3\*</sup>

1. Assistant Professor, Faculty of Agriculture, Zabol University

2. Associate Professor, Faculty of Agriculture, Zabol University

3. PhD Candidate, Faculty of Agriculture, University of Zabol

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### ABSTRACT

Shortage of water resources in the country together with high water losses in the conventional surface irrigation, has increased the attention of the experts to methods of pressurized irrigation systems, especially drip irrigation equipped with tape pipes (because of the low operating pressure and low cost of pipes) as well as optimal use of water resources for cultivation of such highly consumed crops as corn. On this basis, the present study was performed to determine the effects of different levels of irrigation water, plant density and planting pattern on yield, yield components and Water Use Efficiency (WUE) in corn, variety single cross 700 (700KSC), using drip irrigation (tape), at the Research Station of Islamabadgharb within two consecutive years (2011-2012). The project was carried out in the form of a split block factorial design in which the vertical bar was irrigation factor consisting of four irrigation level of 50, 75, 100 and 125 percent evapotranspiration. The horizontal bars represented planting patterns including two planting patterns of one vs. two-rows. Plant density consisted of three densities of 65, 75, and 85 thousand plants per hectare, implemented as a factorial of three replications. The results showed that the level of irrigation and plant density (at 1% level) and their interactions at a level of 5%, created significant difference as regards water use efficiency. Fifty percent treatment of the water requirement of corn with 0.8 kilograms per cubic meter and 100% treatment of the water requirement, with 1.25 kilograms of corn per cubic meter, respectively, presented the lowest vs. the highest water use efficiencies. Different levels of irrigation water created difference at 1% level in yield, so that 125% treatment of evapotranspiration, with 11320 kg per hectare had yielded the highest, and 50% treatment of evapotranspiration, with 3442 kg per hectare, presented the lowest yield. Yield was also influenced by the density and planting pattern with significant differences at 1% level. A density of 65 thousand plants and planting pattern on one-row with 6596 and 7894 kg per hectare resulted in the lowest yields. The density of 75 thousands plants per hectare and planting pattern of two-rows respectively with 8809 vs. 8195 kg per hectare rendered the highest yield. The interaction between irrigation levels and plant density created difference (at 1% level) in yield. But as regards the interaction between irrigation levels and planting pattern as well as irrigation levels, density and planting pattern, the effect of year and replication did not create significant differences on any of the experimented factors.

**Keywords:** Tape drip irrigation, Evapotranspiration, Water depth, Evaporation pan

## **An Evaluation of the performance of Center Pivot Systems Practiced on the Moghan Agro-Industry and Livestock Farms**

**YASER HAMDI AHMAD ABAD<sup>1\*</sup>, ABDOLMAJID LIAGHAT<sup>2</sup>, TEYMUR SOHRABI<sup>3</sup>, ALI RASOULZADE<sup>4</sup>, BIJAN NAZARI<sup>5</sup>, AMIN LIAGHAT<sup>6</sup>**

1. Graduate Student, Department of Irrigation and Reclamation Engineering, University of Tehran
2. Professor, Department of Irrigation and Reclamation Engineering, University of Tehran
3. Professor, Department of Irrigation and Reclamation Engineering, University of Tehran
4. Associate Professor, Department of Water Engineering, University of Mohaghegh Ardabili
5. Assistant Professor, International University of Imam Khomeini
6. Graduate Student, Department of Irrigation and Reclamation Engineering, University of Tehran

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### **ABSTRACT**

An Evaluation of the implemented sprinkler irrigation systems, made it possible to determine the systems' level of success in performance; presenting practical solutions to improve the efficiency of the systems and finally offering suggestions for improvement of the future systems. The main objective followed in this study was to evaluate the status and performance of the implemented center pivot systems in the study area. Throughout the study, 5 center pivots laid out on any of the alfalfa, maize and sugar beet fields in Moghan Agro-Industry and Livestock farms. Each system was evaluated within three sets of experiments. The results showed that, the average distribution coefficient, distribution uniformity, PELQ, AEQL, evaporation and wind drift losses were estimated at about 47.5, 60.4, 50.1, 50.1 and 7.6, respectively. Analyses of these evaluation parameters showed that the existing center pivot systems in the study area were not efficient. The low efficiency of these systems was the results of improper management and technical issues that had not been properly taken into consideration. The reasons for the low levels of AELQ and PELQ consisted of poor design and improper operation that should be paid attention to and revised.

**Keywords:** AELQ, distribution coefficient, distribution uniformity, PELQ, performance evaluation.

## An Evaluation of Image Processing Technique in Estimating Manning's Roughness Coefficient within the Surface Layer of Riverbeds

FARZAM HASSANNEZHAD SHARIFI<sup>1</sup>, AMIR SAMADI<sup>2\*</sup>, ASGHAR AZIZIAN<sup>3</sup>

1. Graduate Student, Water Eng. Depart., Faculty of Eng.and Tech., Imam Khomeini Internatinal University (IKIU)
2. Assistant Professor, Water Eng. Depart., Faculty of Eng.and Tech., Imam Khomeini Internatinal University (IKIU)
3. Assistant Professor, Water Eng. Depart., Faculty of Eng.and Tech., Imam Khomeini Internatinal University (IKIU)

### ABSTRACT

Considering the importance of a reasonable estimation of roughness coefficient in river engineering studies as well as especially in the case of flood zoning investigations as well as a determination of riverbed extents, an evaluation of image processing technique in estimating Manning's roughness coefficient within the surface layer of riverbeds was carried out throughout the present study. The mentioned approach of evaluation was conducted through a simultaneous implementation of sieving analysis and digital image processing methods, within a 7.5km reach of Shalmanrood River, Guilan. The processing of captured images signifies that this technique possesses an excellent accuracy in estimating the size of sediment particles (particles of a size of  $d_{50}$  or larger) and can be employed to estimate Manning's roughness coefficient of sediment particles of riverbed, utilizing the given empirical formulas. To evaluate the image processing results in estimating Manning's coefficient values, one-dimensional modeling by HEC-RAS Hydraulic model was used and the model conducted through different scenarios. Finally, on given cross sections, the comparison of output hydraulic properties with respect to Cowan' method results showed that Bray's empirical formula ( $d_{90}$ ) will present the best efficiency in estimating the Manning's roughness coefficients within the surface of the riverbed. Hence, it is concluded that it is possible to improve results' accuracy using image processing technique in estimation of roughness coefficient in river engineering studies.

**Keywords:** Surface particles, Image processing, Manning's roughness coefficient, Cowan's method, Hec-Ras

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\* Correspondent author's E-mail: amsamadi@gmail.com

## Investigation of Dynamic Pressure of Vertical and Circular Free Water Jets on Rough Surfaces with Variable Angles

SAJAD KIANI<sup>1</sup>, MANOOCHEHR FATHI-MOGHADAM<sup>2\*</sup>, BABAK LASHKAR-ARA<sup>3</sup>, MAHER OBEYDAVI<sup>4</sup>

1. PhD Student, Faculty of Water Science Engineering, Shahid Chamran University of Ahvaz

2. Professor, Faculty of Water Science Engineering, Shahid Chamran University of Ahvaz

3. Assistant Professor, Jundi-Shapur University of Technology, Dezful

4. M.Sc. Graduate, Faculty of Water Science Engineering, Shahid Chamran University of Ahvaz

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### ABSTRACT

The security and stability of dams for flood passing through the spillway should be provided. So, kinetic energy of flow over large spillway must be dissipated. One of the energy dissipation structures at downstream dams, are plunging pools. The aim of this paper is to investigate dynamic pressure that is created by the impact of a series of rounded non-submerged jets on a flat plate with the roughness height of 0.8 cm in the angles of the impact of 30, 60 and 90 degrees. This research uses sensors to measure the instantaneous pressure (Pressure transducer) with the ability to record and store the dynamic pressure oscillation of water jet. The results showed that increasing the drop height, average coefficient of dynamic pressure decreases. The extreme dynamic pressures coefficient increased with increase fall height. The mean coefficient of dynamic pressure increases with increasing discharge. As the angle of the impact jet decreases, the dynamic pressures reduce. Also, the roughness increases the dynamic pressure up to 70% in the test interval.

**Keyword:** Fall height, Plunging pool, Froude Number, Extreme dynamic pressures

## Development of a Conjunctive use Model with Emphasis on the Quality and Quantity of Water Resources

FATEMEH HEYDARI<sup>1</sup>, MAJID DELAVAR<sup>2\*</sup>, BAHRAM SAGHAFIAN<sup>3</sup>

1. MSc. Student, Faculty of Agriculture, Tarbiat Modares University

2. Assistant Professor, Faculty of Agriculture, Tarbiat Modares University

3. Professor, Islamic Azad University, Science and Research branch, Tehran

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### ABSTRACT

Many real problems in optimal allocation of water resources involve conflicting objectives. In this study, genetic algorithm (NSGA-II) has been developed to optimize the multiobjective conjunctive use of water resources and optimal management of water supply and demand in agricultural sector. For optimal allocation of the land and water resources to dominant products in Najaf Abad plain, two surrogate models, Artificial Neural Network (ANN) and Genetic Programming (GP), has been linked to NSGA-II. The results, according to the values of statistical criteria, confirmed the efficiency of alternative models to predict the TDS concentration and groundwater level at a number of observation wells. The final results of SO model show the average drawdown was limited to 0.18 m under optimal conditions, compared to the current (pre-optimal) drawdown of approximately 0.65 m. The average TDS concentration also decreased from 1258 mg/lit to 1229 mg/lit under optimal conditions.

**Keywords:** Groundwater level, Multi-objective optimization, TDS concentration

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\* Correspondent author's E-mail: m.delavar@modares.ac.ir



## Effect of Temperature on the Behavior of an Expansive Soil during Drying and Wetting Cycles

MOHADDESEH AMINI KELAHROUDI<sup>1\*</sup>, ALI RAEESI ESTABRAGH<sup>2</sup> AND J ABDOLAHI BAIK<sup>3</sup>

1. MSc Student, irrigation and reclamation, university of Tehran

2. Associate Professor, irrigation and reclamation, university of Tehran

3. Lecturer, irrigation and reclamation, university of Tehran

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### ABSTRACT

In this research the mechanical behavior of an expansive soil (with different pore fluid) was investigated under the constant and variable temperature through experimental tests. The soil samples with different pore fluid (distilled water, NaCl and CaCl<sub>2</sub> with concentration of 250 gr/Lit) were prepared by static compaction method. Experimental tests were conducted in two modified odometer under 10 KPa surcharge pressure at constant and variable temperature. The axial deformations of samples were determined during each test. The results showed that equilibrium condition is achieved nearly after 5 cycles. The reduction of swelling potential at equilibrium condition for sample with distilled water as pore fluid is more than samples with NaCl and CaCl<sub>2</sub> solutions. In addition comparing the results for samples with NaCl and CaCl<sub>2</sub> solution in variable and constant temperature indicated that reduction of swelling potential is not the same.

**Keywords:** swelling potential, constant and variable temperature, modified odometer, 10 KPa surcharge

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\* Correspondent author's E-mail: amini.mohadeseh@ut.ac.ir

## Comparison of Gap Filling Methods in Landsat 7 ETM+ Images to Estimate Crop Efficient

MARYAM TAHERPARVAR<sup>1</sup>, NADER PIRMORADIAN<sup>2\*</sup>, MAJID VAZIFEDOUST<sup>3</sup>

1. MSc. Candidate, Water Engineering Department, Faculty of Agricultural Sciences, University of Guilan
2. Assistant Professor, Water Engineering Department, Faculty of Agricultural Sciences, University of Guilan
3. Assistant Professor, Water Engineering Department, Faculty of Agricultural Sciences, University of Guilan

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### ABSTRACT

Landsat 7 ETM+ data is widely used in studies of the spatial distribution  $K_c$  and vegetation cover parameters in regional and global scales but SLC failure has greatly reduces its usefulness. Additionally, the failure is permanent and has failed subsequent attempts to recover the SLC, so required and practical way to address this problem is filling the pixels of missed data in the SLC-off images. Although, there are several proposed methods to fill the gap, but still have filled images quality in heterogeneous area is not satisfactory for more applications. This study was conducted to compare the geostatistics and MODIS auxiliary data methods to fill the pixels of missed data in the SLC-off images. The results showed that the IDW method with NRMSE 6.09% was the best method. The FGMAD and The FAD methods resulted in NRMSE 14.75 and 14.97, respectively. The method of FDCAD presented the lowest accuracy in estimating missed data.

**Keywords:** Remote sensing, Geostatistics, Evapotranspiration

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\* Correspondent author's E-mail: npirmoradian@guilan.ac.ir

## Splash Particle Size Distribution along the Experimental Flume under Different Rainfall Intensities and Slopes

**HAMID REZA SADEGHI<sup>1\*</sup>, MAHBOOBEH KIANI HARCHEGANI<sup>2</sup>, HOSEIN ASADI<sup>3</sup>**

1. Professor, Department of Watershed Management Engineering, College of Natural Resources, Tarbiat Modares University, Noor, Mazandaran

2. Ph. D. Candidate, Department of Watershed Management Engineering, College of Natural Resources, Tarbiat Modares University, Noor, Mazandaran

3. Associate Professor, Department of Soil Science, University of Guilan

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### ABSTRACT

Splash detachment and transport of soil particles by raindrops from the initiating mechanisms of soil erosion by water. The size distribution of splashed particles is very important and effective in the rate of other erosion processes. However, this important issue has been less considered. Therefore, the present study investigated individual as well as the interaction effects of slope, rainfall intensity and spatial variations along the plot as well as upward vs. downward the splash cup. Furthermore, the variables were grouped through Tukey test in RStudio software. The tow-way ANOVA in upward splash cup showed that the rainfall intensities significantly affected all the variables except particles of  $< 2$  micron and skewness of sediment. A variable except  $D_{10}$ , sorting and kurtosis of sediment in downward splash cup significantly differed in varying rainfall intensities and slopes as well as their interaction. Besides that, the Tukey test explained that the rainfall intensity of  $90 \text{ mm h}^{-1}$  significantly and more extensively influenced the study variables as compared with those reported for rainfall intensities of  $30$  and  $60 \text{ mm h}^{-1}$ .

**Keywords:** Rainfall simulator, RStudio software, Variables of Sediment particle size distribution

## **A Study of the Effect of Design and Operation Mismatch on Classic Sprinkler Systems' Efficiency**

**FARSHID RAMEZANI HUMBARI<sup>1\*</sup>, BIJAN NAZARI<sup>2</sup>**

1. Graduate Student, Drainage and Irrigation Department of Water Engineering International University of Imam Khomeini Qazvin

2. Assistant Professor, Department of Water Engineering, International University of Imam Khomeini (RA), Qazvin

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### **ABSTRACT**

Development of modern irrigation systems is part of the key solutions for improving irrigation efficiency, crop yield as well as agricultural water productivity. In this study, the effects of six types of sprinkler arrangement comprised of the proposed arrangement vs. 5 common arrangements in farmers operation on Christiansen Uniformity coefficient (CU), Distribution Uniformity (DU), Actual Efficiency of Low Quarter (AELQ), electromotor Power (P) as well as pumping efficiency were evaluated. Results showed that sprinkler arrangements' mismatch significantly affects system efficiency, and energy consumption. Irrigation pump efficiency in the operation mode based on the planned arrangement of sprinklers was 72 % while in some of the ordinary arrangements it amounted to 52 %. Christiansen Uniformity coefficient (CU) ranged between 78.6 % and 44.8 % in various sprinkler arrangements. This study shows the importance of education and technical training in proper operation of sprinkler irrigation systems in increasing the irrigation efficiency, reducing water losses, improvement in crop yield and as well to reduce the energy costs.

**Keywords:** Uniformity Coefficient, Irrigation Efficiency, Pumping Efficiency, Operation Education.