

## ***New Technologies for Modelling in Agricultural Engineering Education***

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### **Abstract**

In recent years, education of agricultural engineering as a renewal structure has been taught as “education of biosystem” in developed countries. “Education of Biosystem” which is a branch of engineering that includes the application of biological systems and processes as it extends to engineering science. It is related to agricultural engineering and its fields of study are: “agricultural automation and new developing technologies”, “sensitive agriculture techniques”, “sustainable agriculture against to changes of climate”, “determine of suitable agriculture techniques for global warming and climate changes, and “computer programs and applications of modeling”. These subjects include intensive study in the education process. Turkey continues adopting to educational infrastructures in conformity to developed countries and renewing fast developments in leading agricultural techniques and biotechnology science. In this paper, computer programs and modeling were discussed using the educational process and renewal structure of highschoools/vocational schools with the education of the faculty. In addition, teaching of advanced technologies and new trends were examined in terms of globalization and adaptation of mobility based on graduate level of higher education.

**Keywords:** *Agricultural education, biosystem engineering, higher education, modelling, sensitive techniques*

### **1. Introduction**

In agricultural production, the producers need certain information. This information is closely related with application of modern agricultural techniques and the latest technologies of Biosystem Engineering.

In Turkey approximately 35% of total population work in agriculture sector [1]. Therefore, advanced information should be offered to the producers using computer technology. This is only possible with education reforms which renew itself according to the developing technology. Biosystem Engineering is structured to serve at this point by responding to the needs in agricultural education. Precision Farming is given as one example of the many ways to support agricultural production through high technology, with the aim of reducing energy input, maintaining excellent soil conditions and enhancing yield [2].

At the ‘World Forum on Education, Research and Innovation’ which was held in Trieste (Italy) in 2007, the roles of space on environmental challenges were discussed by [3]. Morsillo summarizes topics under three items: **i)** Space and the triangle of knowledge; space and technological innovation, research and education, it’s role on global responses today’s environmental challenges; **ii)** Science and technology supports in environment and climate change, space – based earth observation and monitoring of climate change from space, inter-agency co-operations, contributions to earth observation applications, increasing of integration and synergies, **iii)** Education and investment in Science, Engineering and Technology (SET), Role of careers on knowledge-based society and understanding our planet, education programs and creative learning opportunities of our environments, projects to inspire and motivate students.

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A mathematical model is a description of a system using mathematical concepts and language. The process of developing a mathematical model is termed mathematical modelling. Mathematical models are used not only in the natural sciences (such as physics, biology, earth science, meteorology) and engineering disciplines (e.g. computer science, artificial intelligence), but also in the social sciences (such as economics, psychology, sociology and political science); physicists, engineers, statisticians, operations research analysts and economists use mathematical models most extensively. A model may help to explain a system and to study the effects of different components, and to make predictions about behaviour. In the world, where science, economy and professions became globalized, the profession of “Agricultural Engineering” in Turkey should have a certain “International” equivalent among the professions in the world. In this context, considering the applications in European Union (EU) and particularly in United States (USA) which have a leading role in science and technology and the conditions in Turkey; a comprehensive structuralization whose basic principles will remain unchanged should be developed [4,5].

In this paper, computer programs and modeling were examined using the educational process and renewal structure of highschools, then compared with the education of the faculty. The next part of the paper covers explanation for agricultural engineering.

## **2. Definition of Biosystem Engineering**

Biological Systems Engineering is a discipline based on engineering principles with emphasis on the production and processing of food, fibers, and materials of biological origin. The program is accredited by the Accreditation Board for Engineering and Technology (ABET) [6]. Agricultural and biological engineering embraces a variety of specialty. As new technology and information emerge, specialty areas are created, and many overlap with one or more other areas.

Many students are unaware of Biological Engineering as a discipline, and may wonder what we do. Biological systems engineers design, manage, and

develop system and equipment that produce, package, process, and distribute the world’s food and fiber supplies.

The United State of America is the first country that started and most commonly applied for the education of Biosystems Engineering at the graduate level. Biosystem Engineering is a new research area for Europe as a scientific concept. Especially, studies continue for creating learning programmes which are compatible to the practices of Europe Credit Transfer System (ECTS) at the Agricultural Engineering in European Union Countries. Ireland is a leader at the education of Biosystem Engineering in European Union Countries. The education of Biosystem Engineering is taught at a graduate level in the University of Dublin College in Ireland. This educational term takes four years for the graduate level. The University of Bozok-Yozgat, Uludağ University-Bursa, Sütçü İmam University-Kahramanmaraş and Gaziosmanpaşa University-Tokat were completed studies of adaptation at the education of Biosystem Engineering in Turkey. And also, they are role models for this process. For example; The University of Uludağ have got one year-preparing term and four years-graduate courses for Biosystem Engineering. As total, educational terms are five years-graduate courses.

## **Interesting Focuses of Biosystem Engineering [7] :**

- Automation and newly developed technologies in agriculture
- Agricultural machines
- Techniques of modeling and simulation
- Technologies in vegetal/plant and animal production
- Sensitive agricultural techniques
- Post-harvest mechanization applications
- Management and using of land and water sources
- Agricultural structures and environment
- Sustainability and development of rural areas

## **Work Areas of Biosystem Engineering:**

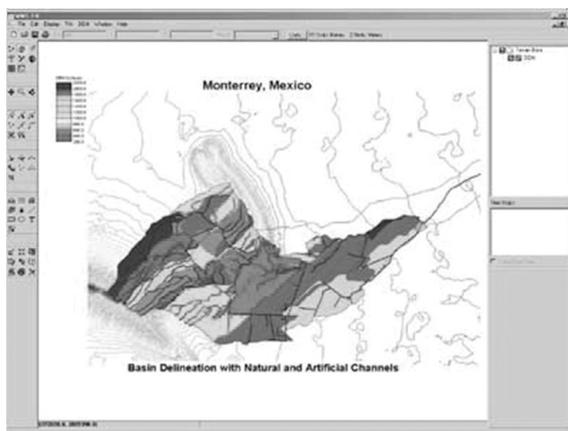
- Governmental sector
- Agricultural machine industry

- Machine industry of food and animal production
- Company of agricultural consultant
- Design office of irrigation and drainage
- Countruction firms of agricultural building
- Agricultural international trade

### 3. Modelling and New Technologies

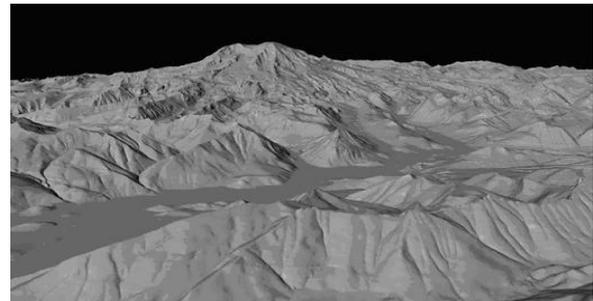
New Technologies and Adaptation of Trends of Modelling in Education of Biosystem and Agricultural Engineering are summarized in this section.

**Surface Modelling:** EMS-I specializes in hydrologic and hydraulic modeling of watersheds and rivers using the most comprehensive watershed analysis system: The Watershed Modeling System (WMS software) (Fig. 1) is a comprehensive graphical modeling environment for all phases of watershed hydrology and hydraulics. WMS includes powerful tools to automate modeling processes such as automated basin delineation, geometric parameter calculations, GIS overlay computations (cloud nucleus, rainfall depth, roughness coefficients, etc.), cross-section extraction from terrain data, and many more! With the release of WMS 7, the software now supports hydrologic modeling with HEC-1 (HEC-HMS), TR-20, TR-55, Rational Method, NFF, MODRAT, and HSPF [8].



**Figure 1.** Surface Modelling: The Watershed Modelling System (WMS)

**Dijital Elevation Model (DEM):** A digital elevation model (DEM) is a digital representation of ground surface topography or terrain. It is also widely known as a digital terrain model (DTM). A DEM can be represented as a raster (a grid of squares) or as a triangular irregular network. DEMs are commonly built using remote sensing techniques, but they may also be built from land surveying. DEMs are used often in geographic information systems, and are the most common basis for digitally-produced relief maps [9]. Digital Elevation Model (DEM) can be defined as a model which expresses the topography of the earth in its simplest form, three-dimensionally using X, Y planimetric and Z elevation values. Figure 2 indicates an example of Digital Elevation Model.



**Figure 2.** Digital Elevation Model (DEM)

**Digital Terrain Models (DTM):** DTM includes details with different elevation values on topography such as buildings, flora, forest etc and reflects the visible topography. In this course the students will learn mathematical bases of digital terrain models and digital surface models based on 3 dimensional coordinate data. They will also learn mathematical basis of different filtering and collocation calculation methods which are used in professional stabilizing calculation. They will learn mathematical and methodological information about interpolation techniques used in formation of digital terrain and surface models. In practice, among a range of digital calculation programs, digital calculations in Microsoft Excel and Golden Surfer software and method will be taught to the students [10].

**Wavelet (Mathematical Model):** A wavelet is a wave-like oscillation with an amplitude that starts out at zero, increases, and then decreases back to zero. It

can typically be visualized as a "brief oscillation" like one might see recorded by a seismograph or heart monitor. Generally, wavelets are purposefully crafted to have specific properties that make them useful for signal processing. Wavelets can be combined, using a "shift, multiply and sum" technique called convolution, with portions of an unknown signal to extract information from the unknown signal. Figure 3 indicates an example wavelet signals [11]. Interpretation of 1D Continuous Wavelet and 1D Wavelet Packets explain small, meso and large scale influences on agricultural productions [12].

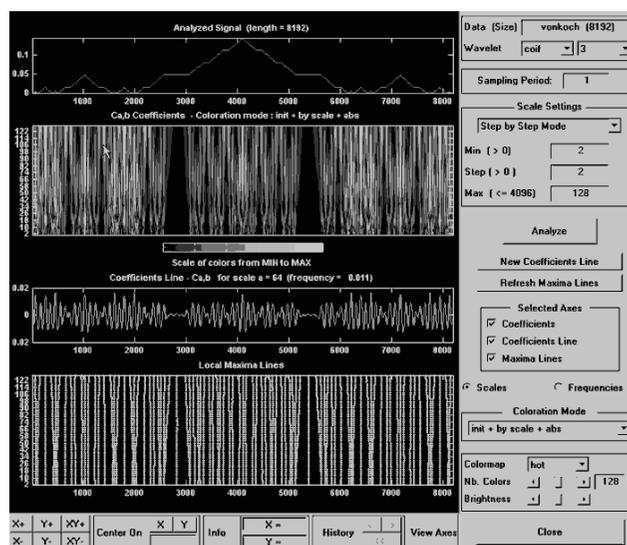


Figure 3. Wavelet Signals

**Matlab:** It is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numeric computation [13]. Using the Matlab product, you can solve technical computing problems faster than with traditional programming languages, such as C, C++, and Fortran. You can use Matlab in a wide range of applications, including signal and image processing, communications, control design, test and measurement, financial modeling and analysis, and computational biology. Add-on toolboxes (collections of special-purpose Matlab functions, available separately) extend the Matlab environment to solve particular classes of problems in these application areas (Fig. 4). Matlab provides a number of features for documenting and sharing your work. You can

integrate your Matlab code with other languages and applications, and distribute your Matlab algorithms and applications [14].

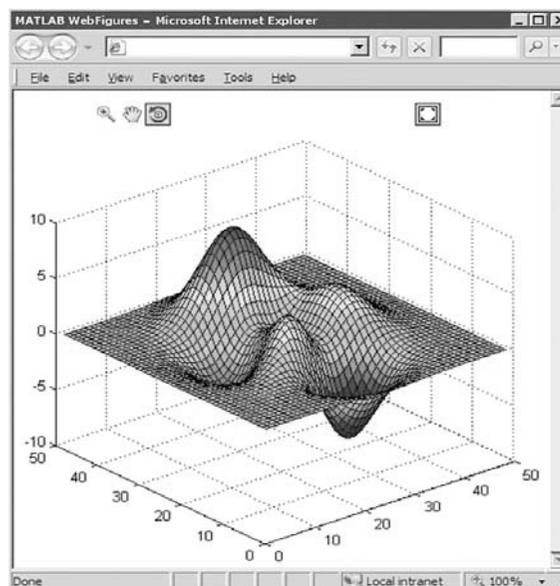


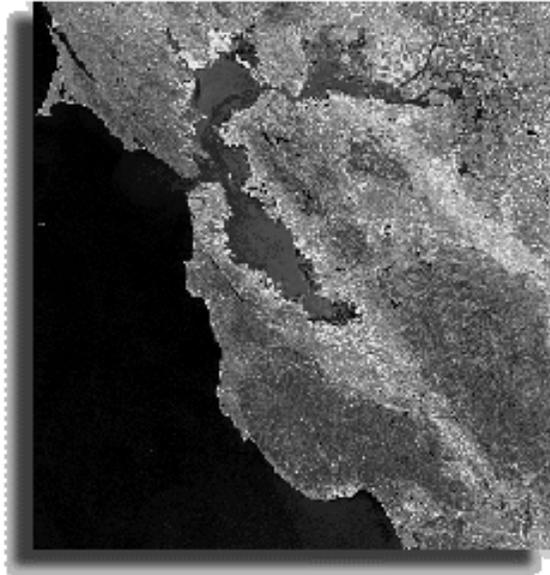
Figure 4. Applications of Matlab

**SWS:** SWS has been developed by USDA-ARS E. Brown Jr. Salinity Laboratory. SWS performs simulations on water and soil chemistry. The model takes in to account the carbonate chemistry very precisionally which is very important for alkalinity and salinity simulations and this particularity makes the SWS distinctive among the other model [15]. This model was developed to evaluate the appropriateness of the quality of the irrigation water, salinity and the qualities of alkalinity particularly in arid and semi-arid regions.

**GIS:** The definition of Geographic Information Systems, the properties of raster and vector data, preparation of soil maps and digital soil maps in data bases, the role of GIS in sustainable use of natural sources, the use of digital soil data in pollution and erosion model studies, advanced GIS software such as CBS, Arc View, Arc Info, Grass Land are used in management of soil and water sources [10].

**Landsat:** The Landsat Program is the longest running enterprise for acquisition of imagery of the earth from space. The instruments on the Landsat satellites have

acquired millions of images. The images, archived in the United States and at Landsat receiving stations around the world, are a unique resource for global change research and applications in agriculture, geology, forestry, regional planning, education and national security (Fig. 5.), [16].



**Figure 5.** Landsat Thematic Mapper image of the San Francisco Bay Area (sampled): 60 kbytes

**RUSLE (Water Erosion Estimation Models):** They are used in studies on the importance of water erosion, the history of soil loss estimation equations, soil loss tolerance, revised universal soil loss equation and factors values.

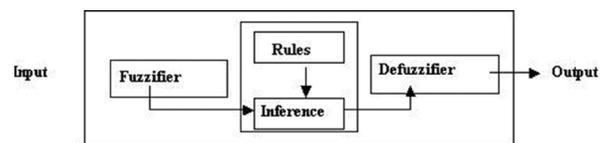
**Mathematical Models in Irrigation and Drainage:** They are used in researches and various mathematical models [10].

**Irrigation Programming Techniques:** Different irrigation programming methods and techniques are used according to irrigation methods.

**SALT-MOD:** SaltMod is a mathematical, numerical computer program for the simulation and prediction of the salinity of soil moisture, ground and drainage water, the depth of the watertable (water table), drain discharge and leaching of salts in irrigated agricultural lands under different geohydrologic conditions,

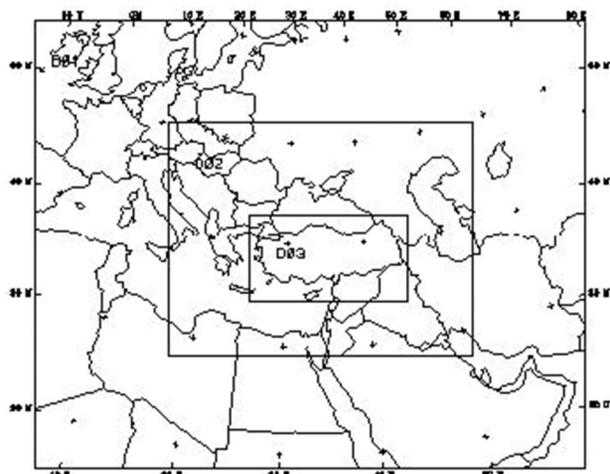
varying water management options, including the (re)use of groundwater for irrigation by pumping from wells (conjunctive use), and several crop rotation schedules. It uses salt and water balances. The model aims at sustainable land use and environmentally sound optimal water management for sustainability and can be used for the reclamation (remediation, rehabilitation, restoration) of saline soils [17].

**Fuzzy-Logic:** Fuzzy logic is a form of multi-valued logic derived from fuzzy set theory to deal with reasoning that is approximate rather than precise. In contrast with "crisp logic", where binary sets have binary logic, the fuzzy logic variables may have a membership value of not only 0 or 1 – that is, the degree of truth of a statement can range between 0 and 1 and is not constrained to the two truth values of classic propositional logic [18]. Fuzzy logic emerged as a consequence of the 1965 proposal of fuzzy set theory by Lotfi Zadeh [19, 20]. Furthermore, when linguistic variables are used, these degrees may be managed by specific functions. Figure 6 shows a Fuzzy Logic System [21].



**Figure 6.** A Fuzzy Logic System

**Numerical Experiments:** Numerical model was setup using three nested grids using (45x55), (70x91), and (79x142) grid points in (north-south x west-east) directions using 108, 36, and 12 km horizontal grid spacing, respectively (Fig. 7). MM5 was configured using simple ice microphysics for the treatment of excess moisture, cumulus to parameterization of convective motions, boundary layer to resolve the atmospheric flow within the boundary layer, Rapid Radiative Transfer Model (RRTM) for calculation of radiation and 5-layer soil model for the calculation of surface fluxes [22].



**Figure 7.** The setup of the three nested grids

NCAR's next generation non-hydrostatic mesoscale model, Advanced Research WRF (WRF-ARW) are used to analyse complex topography and variable climate conditions [23].

**ICTP-RegCM3 model** that is based on MM5, the predecessor of WRF. WRF on the other hand, is superior to RegCM and MM5 in both physics, dynamics and numerics, but computationally more expensive accordingly. However, WRF is still under development and requires more performance analyses for its validation in regional climate modelling.

**CORINE** soil erosion assessment methodology the following maps would be prepared; Land use maps, aspect maps, slope maps, topographic maps, land cover maps, soil erodibility maps [24].

### 3. Results

When advanced technologies and new modeling trends take place at the graduate level, these processes will help globalization of biosystem education. Besides, adaptation will be easier for international student exchange.

#### **Adaptation Process at the Education of Biosystem Engineering**

1. Decision theory should be developed for education

2. Decision-support alternatives should be determined
3. Education strategies should be set out
4. Every country should consider its own educational facts and determine their requirements
5. Potential production must be determined according to ecological characteristics of country
6. Using of modern and advanced technologies take place to the education of agricultural (Exp: monitoring, controlling, automation, mechanization, fertilizer, fumigation, harvesting, irrigation, packing house etc.,).

Advantages of adaptation in biosystem engineering are:

1. Integration with the world is achieved
2. Student profile and quality increased
3. The students prefer "Biosystem Engineering" consciously and upon their will
4. Adaptation of globalization and changing is easier at the education of agricultural
5. To help common and sustainable agricultural education according to global changing of climate
6. To focus on the constituents of international agricultural education
7. To increase the quality of education to be able to compete in agricultural education in national and international level
8. Accreditation of the courses and diplomas is completed the level of international and global
9. Integration of evaluation of diploma and titles of the participants from other countries prior to masters or doctorate programs with re-structuralization

#### **Training: A Case Study**

- Short courses for students, post-graduates etc. on specific research issues should be organized,
- One international workshop has to be organized, which will manage the workshops directly with the partner or group of partners involved.

Working programs (WP1-3) and Logical Frame Works would be listed as below (Table 1):

**Table 1.** Details on working programs for developing curriculum (sample for work packets)

WP1	Project web site: Portal connection to project Dbases and external links
	1 <sup>st</sup> International Workshop
	Coordination of the WGs activities: WGs meetings
	COORDINATION PLENAREY meetings
	Coordination of the information network between the ECVET partners
WP2	Data bases of: training programs complete case studies
	Training activities and short courses
	Exchanges of researchers, short-term visits, etc
WP3	Collection of existing programs
	Validation of new programs with case studies applications
	Development curriculum
	Development of guidelines for curriculum studies.

#### 4. Conclusion

“Education of Agricultural Engineering” which is a branch of engineering that includes the application of biological systems and processes as it extends to engineering science. It is related to agricultural engineering and its fields of study are: “agricultural automation and new developing technologies”, “sensitive agriculture techniques”, and “computer programs and applications of modeling”. These subjects include intensive study in the education process.

Nowadays, advanced technologies uses are increasing everyday. However, in the world of globalization technologies re-structural changing and adaptation of international norms are necessary in the education of agricultural. In the respect that techniques of modeling and simulation take place at the graduate and

vocational level of universities during the teaching processes. During the educational process, these techniques support for student’s thesis, projects and their homework. So, students will be able to practice in relation to their technical course.

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