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## 7TH INTERNATIONAL CONFERENCE ON ENVIRONMENTAL SCIENCE AND TECHNOLOGY

June 23-27, 2021

# BOOK OF PROCEEDINGS

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# WELCOME TO ICOEST 2021

*On behalf of the organizing committee, we are pleased to announce that the 7th International Conference on Environmental Science and Technology (ICOEST-2021) is held from June 23-27, 2021 in Bosnia and Herzegovina (Hybrid Conference). ICOEST 2021 provides an ideal academic platform for researchers to present the latest research findings and describe emerging technologies, and directions in Environmental Science and Technology. The conference seeks to contribute to presenting novel research results in all aspects of Environmental Science and Technology. The conference aims to bring together leading academic scientists, researchers and research scholars to exchange and share their experiences and research results about all aspects of Environmental Science and Technology. It also provides the premier interdisciplinary forum for scientists, engineers, and practitioners to present their latest research results, ideas, developments, and applications in al lareas of Environmental Science and Technology. The conference will bring together leading academic scientists, researchers and scholars in the domain of interest from around the world. ICOEST 2020 is the oncoming event of the successful conference series focusing on Environmental Science and Technology. The scientific program focuses on current advances in th eresearch, production and use of Environmental Engineering and Sciences with particular focus on their role in maintaining academic level in Science and Technology and elevating the science level such as: Water and waste water treatment, sludge handling and management, Solid waste and management, Surface water quality monitoring, Noise pollution and control, Air pollution and control, Ecology and ecosystem management, Environmental data analysis and modeling, Environmental education, Environmental planning, management and policies for cities and regions, Green energy and sustainability, Water resources and river basin management. The conference's goals are to provide a scientific forum for all international prestige scholars around the world and enable the interactive exchange of state-of-the-art knowledge. The conference will focus on evidence-based benefits proven in environmental science and engineering experiments.*

***Best regards,***

***Prof. Dr.Özer ÇINAR***

ICOEST SARAJEVO
7TH INTERNATIONAL CONFERENCE ON ENVIRONMENTAL SCIENCE AND TECHNOLOGY
June 23-27 2021 (Hybrid Conference)

# Hydrological Modelling at Ladik Lake Basin (Turkey) Using SWAT

***Gulhan Ozdogan-Sarıkoc*[1]*, Filiz Dadaser-Celik*[2]**

**_Abstract_**

*This study aims to develop a hydrologic model for the Ladik Lake Basin in Turkey using the Soil and Water Assessment Tool (SWAT). Ladik Lake is located in the Yesilirmak River Basin in Samsun, Turkey and covers an area of about 10 km$^2$. The lake supplies irrigation water to 88 km$^2$ command area. In this study, the water volumes in the Ladik Lake were simulated with SWAT. SWAT is a semi-distributed hydrologic model that can be used for simulating hydrology, water quality, crop development, irrigation operations. In this study, SWAT model was established based on digital elevation model, land use, soils, and slope data and meteorological data. Irrigation withdrawals were simulated using auto irrigation tool, which determines the timing and amount of irrigation according to the plant water stress factor. SUFI-2 algorithm was used for calibration and validation of the model for lake volumes. The model was run at the monthly time step over the period 2010-2017. The Nash-Sutcliffe Efficiency (NSE) between the measured and simulated water volumes was calculated as 0.66 and the coefficient of determination ($R^2$) was calculated as 0.67 for the calibration period (2010-2015). For the validation period (2015-2017), NSE was 0.58 and $R^2$ was 0.60. These results showed that SWAT can successfully simulate the hydrological processes in the Ladik Lake basin.*

**Keywords:** Hydrological Modelling, Ladik Lake, Irrigation, SWAT

## 1.INTRODUCTION

Hydrology studies the formation, circulation, distribution, chemical, and physical properties of water on the earth and its interaction with the environment, including their relationships with living things [1]. Various changes have occurred in the hydrological system due to deforestation, land cover change, irrigation, rapid urbanization, and industrialization [2].

A hydrological model is a simplified representation of a real world system [3]. Hydrological models can be used to predict system behavior and to understand various hydrological processes. Hydrological models are recognized as important and necessary tools for better characterizing hydrological processes in basins and for the management of water and environmental resources. In this study, a physically-based model, Soil and Water Assessment Tool (SWAT) [4] was used for hydrological modeling at Ladik Lake.

The studies conducted so far in Ladik Lake mostly reveal the length and weight relationships of the creatures living in the lake [5-8] and their biological characteristics [9], growth and reproductive characteristics [10-12], heavy metal accumulation on different living species [13, 14], epiphytic diatom [15], zooplankton composition [16] and lake phytoplankton [17]. Kılıç [18] investigated the changes in the water area and water level at Ladik Lake for the 1999-2019 period using remote sensing techniques. This study showed that the lake area has shrunk due to the excessive use of water for irrigation purposes after 2009.

In this study, we develop a hydrologic model using SWAT in order to understand water volume changes at Ladik Lake.

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## 2.STUDY AREA

Ladik Lake is located in the Yesilirmak River Basin within in the boundaries of Samsun province, Turkey. Ladik Lake was declared a "Wetland of National Importance" in 2015 [19]. It is home to a large number of endangered plant and animal species.

The lake is a tectonic lake and covers an area of about 10 km$^2$ (Figure 1). It is fed by continuous and seasonal streams and it discharges into Tersakan Stream. Water from the lake is also used for irrigation. It supplies irrigation water to 88 km$^2$ command area as part of Amasya-Suluova agricultural irrigation project [20].

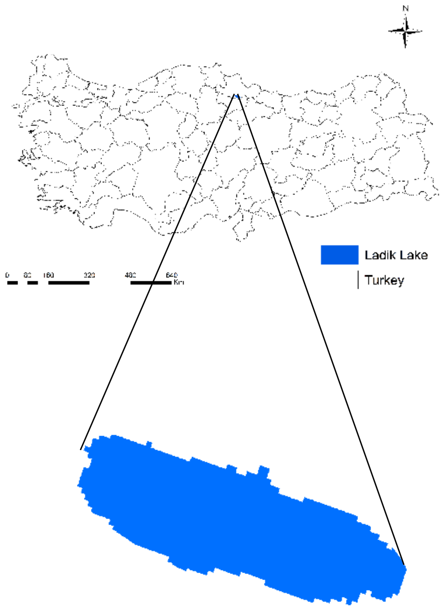


*Figure 1. Location of Ladik Lake.*

Annual average air temperature in the region is 11.9°C and average annual precipitation is 443 mm based on data from the 2000-2017 period. Figure 2 shows annual average air temperature and annual precipitation at the Ladik Lake Basin during the 1975-2019 period. We see an upward trend in air temperatures from 1975 to 2019, while precipitation mostly remains stable.

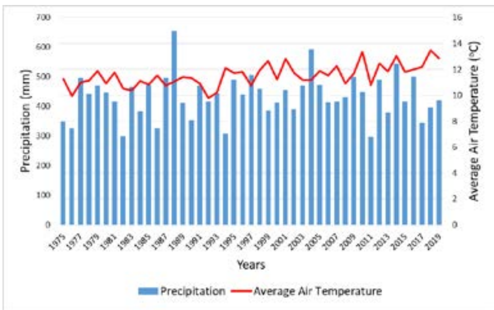


*Figure 2. Annual average air temperature and annual precipitation at the Ladik Lake Basin during the 1975-2019 period.*

## 3.MATERIALS AND METHODS

SWAT was used for simulating hydrologic conditions at Ladik Lake.

- ***Model setup***

SWAT requires digital elevation model (DEM), soils, and land use/cover data, and meteorological data (minimum and maximum air temperature, precipitation, relative humidity, solar radiation and wind speed) for model setup. Reservoir volumes on monthly time step are also required for model calibration and validation. Data used in this study and data characteristics are shown in Table 1.

*Table 1. Detailed information for data.*

| Data | Data Source | Spatial / Temporal Resolution |
|---|---|---|
| Digital Elevation Model | State Hydraulic Works | 10m × 10m |
| Soils | FAO-UNESCO world Soil Map | 1/5.000.000 |
| Land Use/Cover | CORINE 2018 | 30m × 30m |
| Climate | State Meteorology Service | Daily |
| Reservoir Storage | State Hydraulic Works | Monthly |
| Land Management | Local Agricultural Experts | - |

Ladik Lake model was developed as a part of a larger scale model developed for Tersakan River Basin. During model setup, DEM data were used for defining stream network and basin and subbasin boundaries. Hydrological response units (HRU) were created by combining soil, land use/cover, and slope data within different subbasins. Overall, the model included 8 subbasins and 220 HRUs (Figure 4). Ladik Lake was located in Subbasin 2 and irrigation from Ladik Lake took place in Subbasins 1 and 2. Therefore, we focused on these subbasins during model calibration and validation for Ladik Lake reservoir volumes.

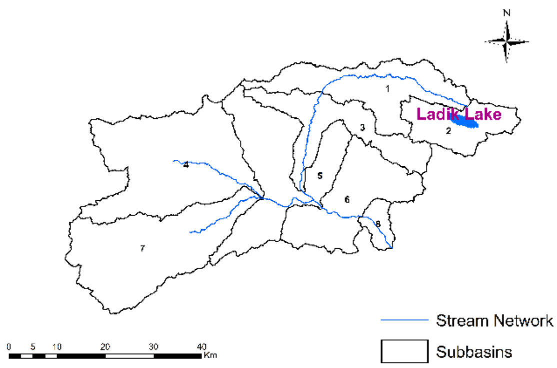


*Figure 4. Tersakan River Basin, stream network, and Ladik Lake subbasin.*

In this study, data regarding land management practices in agriculture were added to represent irrigation from Ladik Lake (Table 2). The management operations data included information about timing and characteristics of tillage, fertilizer applications, auto-irrigation, and harvest and kill operations. We did not have information about the amount of irrigation water use from Ladik Lake. Therefore, auto-irrigation operation was selected to simulate irrigation water use from the reservoir. We accepted that apple orchards and sugar-beets production took place in irrigated areas.

The model was run on monthly time step for the 2005-2017 period and the warm-up period was chosen as 5 years. SUFI2 algorithm available in SWAT-CUP, a program developed for calibration and validation of SWAT, was used for model calibration and validation [21]. Monthly water volume data for Ladik Lake for the 2010-2014 period (60 months) were used for calibration and data from the 2015-2017 period (36 months) were used for validation.

Table 3 and Table 4 show parameters and ranges used in calibration and validation for flow and reservoir volume, respectively. While selecting these parameters, the parameters affecting the reservoir storage volume and the amount of water used for irrigation were taken into consideration.

*Table 2. Management operations and explanation added to the model.*

| **Apple** | | | |
|---|---|---|---|
| **Year** | **Month** | **Operation** | **Explanation** |
| 1 | 3 | Plant/begin growing season | Apple |
| 1 | 3 | Auto-fertilization | Elemental Nitrogen |
| 1 | 3 | Auto-fertilization | Elemental Phosphorous |
| 1 | 5 | Auto-irrigation | Plant Water Demand |
| 1 | 10 | Harvest and kill | Apple harvest |
| **Sugar beet** | | | |
| **Year** | **Month** | **Operation** | **Explanation** |
| 1 | 3 | Fertilizer Application | 40 kg/ha Elemental Phosphorous |
| 1 | 3 | Fertilizer Application | 180 kg/ha Elemental Nitrogen |
| 1 | 3 | Plant/begin growing season | Sugar beet |
| 1 | 5 | Auto-irrigation | Plant Water Demand |
| 1 | 10 | Harvest and kill | Sugar beet harvest |
| 1 | 10 | Tillage | Moldboard Plow 2 way 4-6b |
| 1 | 11 | Fertilizer Application | 80 kg/ha Elemental Phosphorous |
| 1 | 11 | Tillage | Moldboard Plow 2 way 4-6b |

*Table 3. Parameters chosen to be used in flow calibration, definition of parameters, intervals and type of calibration (v represents replace change. New value instead of default parameter values)*

| Parameters | Definition | Lower Limit | Upper Limit | Calibration Type | Calibration Value |
|---|---|---|---|---|---|
| CN2.mgt | Curve number for moisture condition | -0.1 | 0.1 | r | -0.154889 |
| ALPHA_BF.gw | Baseflow alpha factor. | 0 | 1 | v | 0.760899 |
| GW_DELAY.gw | Groundwater delay. | 0 | 50 | v | 8.182090 |
| GWQMN.gw | Threshold depth of water in the shallow aquifer required for return flow to occur. | 100 | 700 | v | 108.712051 |
| CH_N2.rte | Manning's "n" value for the main channel. | 0 | 0.3 | v | 0.082613 |
| CH_K2.rte | Effective hydraulic conductivity in main channel alluvium. | 0 | 10 | v | 2.588405 |
| GW_REVAP.gw | Groundwater "revap" coefficient. | 0 | 0.1 | v | 0.036001 |
| REVAPMN.gw | Threshold depth of water in the shallow aquifer for "revap" to occur. | 0 | 500 | v | 278.602478 |
| SOL_AWC(1).sol | Available water capacity of the soil layer. | -0.5 | 0.6 | r | 0.369330 |
| SOL_BD(1).sol | Moist bulk density. | -0.5 | 0.6 | r | -0.187008 |
| SFTMP.bsn | Snowfall temperature. | -5 | 5 | v | -1.539491 |
| OV_N.hru | Manning's "n" value for overland flow. | 0.01 | 1.0 | v | 0.903051 |
| SLSUBBSN.hru | Average slope length. | -0.1 | 0.2 | r | -0.085284 |
| ESCO.hru | Soil evaporation compensation factor. | 0 | 1 | v | 0.941368 |
| SOL_K(1).sol | Saturated hydraulic conductivity. | -0.8 | 0.8 | r | -0.137758 |
| RCHRG_DP.gw | Deep aquifer percolation fraction. | 0 | 1 | v | 0.027365 |
| GWHT.gw | Initial groundwater height. | 0 | 25 | v | 10.981455 |
| SURLAG.bsn | Surface runoff lag time. | -0.5 | 0.6 | r | 0.878668 |
| EPCO.hru | Plant uptake compensation factor. | 0 | 1 | v | 0.775981 |
| SNOCOVMX.bsn | Minimum snow water content that corresponds to 100% snow cover. | 0 | 50 | v | 66.418297 |
| SMTMP.bsn | Snow melt base temperature. | -5 | 5 | v | -0.473332 |
| SMFMX.bsn | Maximum melt rate for snow during year (occurs on summer solstice). | 0 | 10 | v | 1.954915 |
| TIMP.bsn | Snow pack temperature lag factor. | 0 | 1 | v | 0.705938 |
| SMFMN.bsn | Minimum melt rate for snow during the year (occurs on winter solstice). | 0 | 10 | v | 2.188665 |

*Table 4. Parameters chosen to be used in reservoir storage calibration, definition of parameters, intervals and type of calibration (v represents replace change. New value instead of default parameter values)*

| Parameters | Definition | Lower Limit | Upper Limit | Calibration Type | Calibration Value |
|---|---|---|---|---|---|
| EVRSV.res | Lake evaporation coefficient | 0 | 1 | v | 0.527400 |
| RES_K.res | Hydraulic conductivity of the reservoir bottom (mm/hr) | 0 | 1 | v | 0.024410 |
| IRR_EFF.mgt | Irrigation efficiency | 0 | 1 | v | 0.983732 |
| AUTO_WSTRS.mgt | Plant water stress factor | 0 | 1 | v | 0.342537 |
| GWQMN.gw | Threshold depth of water in the shallow aquifer required for return flow the occur (mm $H_2O$) | 100 | 700 | v | 108.712051 |

We used Nash-Sutcliffe Efficiency Coefficient (NSE), Root Mean Square Error (RMSE), Coefficient of Determination ($R^2$), Kling-Gupta Efficiency (KGE), and Percent Error Statistics (PBIAS) for evaluating the performance of model calibration/validation. We accepted that the model performance is satisfactory when $R^2$, NSE, and KGE are higher than 0.5 and RSR is higher than 0.6, and PBIAS is smaller than 25 or larger than -25 [22].

## 4.RESULTS AND DISCUSSION

A SWAT model was developed and calibrated and validated for the reservoir volumes of Ladik Lake. The purpose of the calibration process is to select model parameters in order to get the best fit between the simulated and measured values. In this study, we used the SUFI2 algorithm in the SWAT-CUP program for calibrating the model for reservoir volumes. In the calibration, using the lower and upper limit values assigned to each parameter, iterations were run until the best result was obtained. In each iteration, 500 simulations were run. At the end of each iteration, another iteration was started by using the new parameter ranges suggested by the program. This process continued until the performance criteria are met [23].

Performance measures calculated during calibration and validation processes are shown in Table 5. Figure 5 shows the graphical representation of observed and simulated water volumes with best parameter set.

*Table 5. Performance values taken for calibration of reservoir data*

| | $R^2$ | NSE | RSR | PBIAS | KGE |
|---|---|---|---|---|---|
| 1. Iteration | 0.45 | 0.37 | 0.8 | -17.0 | 0.48 |
| 2. Iteration | 0.58 | 0.51 | 0.7 | -14.6 | 0.64 |
| 3. Iteration | 0.62 | 0.60 | 0.63 | -1.9 | 0.76 |
| 4. Iteration | 0.63 | 0.61 | 0.61 | 1.6 | 0.77 |
| 5. Iteration | 0.67 | 0.65 | 0.60 | -9.8 | 0.74 |
| 6. Iteration | 0.67 | 0.66 | 0.59 | -2.7 | 0.8 |
| Validation | 0.60 | 0.58 | 0.64 | -4.7 | 0.61 |

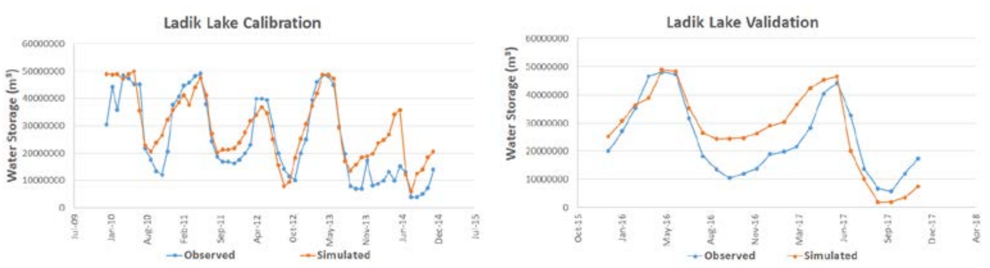


*Figure 5. Observed and simulated monthly water storage at Ladik Lake during calibration and validation*

$R^2$, NSE, RSR, KGE, and PBIAS values were 0.67, 0.66, 0.59, 0.8, and -2.7 respectively, for Ladik Lake during the calibration period. These results suggest that model performance was "good". $R^2$, NSE, RSR, KGE, and

PBIAS values were 0.60, 0.58, 0.64, 0.61, and -4.7 respectively during validation. Results for the validation period were “satisfactory” in terms of $R^2$, NSE, RSR, and KGE and “very good” in terms of PBIAS. The results showed that SWAT can successfully simulate the hydrological process in the Ladik Lake basin.

Simulated inputs and outputs of the reservoir are shown in Figure 6 during the 2010-2017 period. Average annual precipitation (P) of the Ladik Lake is 20 $hm^3$, and surface runoff (Ri) is 243 $hm^3$. Ladik Lake total inputs is 263 $hm^3$. Evapotranspiration (ET) is 30 $hm^3$, and flow out (Ro) is 286 $hm^3$. Ladik Lake total outputs is 316 $hm^3$.

As can be seen, the water inputs and outputs are not in balance for the 2010-2017 period. The difference of 53 $hm^3$ is the change in lake storage. Considering the water levels in the 2010-2017 period, a decrease in water levels and consequently a decrease in the water volume in the lake can be seen.

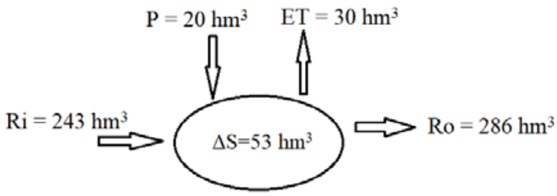


*Figure 6. Inputs and outputs representation Ladik Lake of the SWAT model output*

## 5.CONCLUSIONS

This study contributes important insights into the effectiveness of SWAT for modeling Ladik Lake water volumes. The SWAT model was successful in reproducing the Ladik Lake volumes. In this study we also used auto-irrigation function to simulate water use from the reservoirs.

Despite lack of agriculture and reservoir management data, model performance based on $R^2$, NSE, RSR, KGE and PBIAS was satisfactory.

In the future, we will use the calibrated and validated SWAT model to evaluate the effects of expected climatic change on Ladik Lake volumes.

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# Modeling Climate Change Impacts at Ladik Lake (Turkey) Using SWAT

***Gulhan Ozdogan-Sarıkoc*[1], *Filiz Dadaser-Celik*[2]**

***Abstract***

*This study aims to determine climate change impacts at Ladik Lake in Turkey using the Soil and Water Assessment Tool (SWAT). Ladik Lake is a natural lake and an ecologically important site located in the Yesilirmak River Basin in Turkey. In recent years, water level changes in the lake raised concerns regarding its future hydrologic and ecological characteristics. In this study, we used a basin-scale hydrological model, developed using SWAT, to simulate the sensitivity of Ladik Lake to climatic changes. RCP4.5 and RCP8.5 scenarios developed by MPI-ESM-MR, HadGEM2-ES, and GFDL-ESM2M Global Circulation Models outputs were used for representing future climatic conditions. These models were previously downscaled for Turkey by State Meteorology Service. Maximum and minimum temperature and precipitation projection data were added to the model for the 2021-2098 period. Annual reservoir volume data of 78 years from 2021 to 2098 period has been processed using Mann-Kendall Trend Analysis for the determination of trend (Z value) and slope (Q value) magnitude. The detected trends for the GFDL-ESM2M model were positive (upward) for RCP4.5 and negative (downward) for RCP8.5. While the rate of change in the RCP4.5 was 233 $m^3$/year, this value was -77885 $m^3$/year for the RCP8.5 scenario. The trends determined for the HadGEM2-ES model were negative for both the RCP4.5 and RCP8.5 scenarios. The decrease in RCP4.5 was -1111 $m^3$/year, and the decrease in RCP8.5 was -1786 $m^3$/year. For the MPI-ESM-MR model, the detected trends were negative for both the RCP4.5 and RCP8.5 scenarios. The decrease in RCP4.5 was found to be -126620 $m^3$/year, while the decrease in RCP8.5 was -273806 $m^3$/year. Ladik Lake volume decreased in most of the models and scenarios, except for the GFDL-ESM2M model RCP4.5 scenario. These results suggest that Ladik Lake's water volumes are very sensitive to future climatic changes.*

**Keywords:** Climate Change, Hydrologic Model, Ladik Lake, SWAT

## 1.INTRODUCTION

The Soil and Water Assessment Tool (SWAT) model is a continuation of about 30 years of modeling attempts made by the USDA Agricultural Research Service (ARS) [1]. Until now, many articles on subjects such as streamflow calibration and related hydrologic assessments [2-4], comparisons with other models [5], sensitivity and calibration and validation techniques [6], and sediments yields [7, 8] have been published. In addition to these studies, there are many articles on climate change impacts on streamflow and reservoir storage hydrology on SWAT in the literature [9-13].

Climate change poses a serious threat all over the world and uncertainties arising from population growth create a critical situation for many cities [14]. Population growth increases the demand for water worldwide due to industrialization, land use and climate change, which will likely reduce freshwater availability [3]. Almost all of the climate change projections show significant decreases in future water availability in the Mediterranean region, and the hydrological processes most affected include stream flows, groundwater flows, lakes, and evapotranspiration [15].

Kılıç [16] investigated the changes in the water area and water level at Ladik Lake for the 1999-2019 period using remote sensing techniques. This study showed that there was no excessive water use between 1999 and 2009 and that the lake continued to exist without major changes in the surface area as a result of water use

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taking into account the water budget. After 2009, the excessive use of water, especially for irrigation purposes, has led to a reduction in the lake surface area.

In this study, we used a basin-scale hydrological model, developed using SWAT, to simulate sensitivity of Ladik Lake to climatic changes.

## 2.STUDY AREA

Ladik Lake is located in the Yesilirmak River Basin within in the boundaries of Samsun province, Turkey. Ladik Lake was declared a "Wetland of National Importance" in 2015 [17]. It is home to a large number of endangered plant and animal species.

In Turkey, there are 59 "Wetlands of National Importance" in 2019. Ladik Reservoir was included in this list as an area of 1836 hectares in 2015 [17]. The lake is a tectonic lake and covers an area of about 10 km$^2$ (Figure 1). It is fed by continuous and seasonal streams and it discharges into Tersakan Stream. Water from the lake is also used for irrigation. It supplies irrigation water to 88 km$^2$ command area as part of Amasya-Suluova agricultural irrigation project [18].

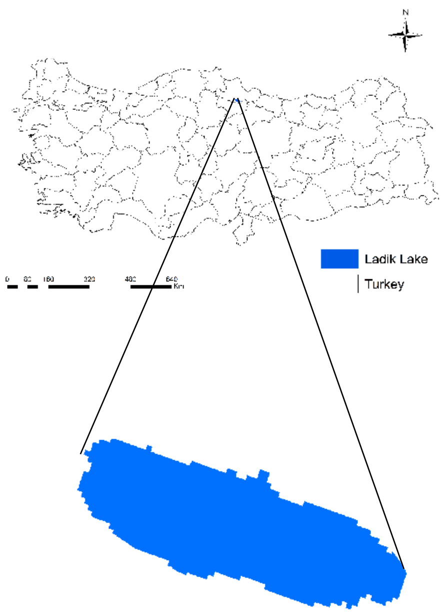


*Figure 1. Location of Ladik Lake.*

Annual average air temperature was 11.9 ºC, and annual average precipitation was 443.1 mm during the 2000-2017 period.

## 3.MATERIALS AND METHODS

In this study, we used a basin-scale hydrological model, developed using SWAT, to simulate sensitivity of Ladik Lake to climatic changes.

- ***SWAT model setup***

Digital elevation model (DEM), soils, slope, land use/cover data, and meteorological data (minimum and maximum air temperature, precipitation, solar radiation, wind speed, and relative humidity) are required for SWAT model setup. Reservoir volumes on monthly time step are also essential for model calibration and validation period.

Stream network, basin, and subbasin boundaries were defined for DEM data. Soil, land use/cover, and slope data were also defined Hydrological response units (HRU). The model included 8 subbasins and 220 HRUs, and Ladik Lake was located in Subbasin 2. Some management operations data added the model. These were tillage, fertilizer applications, auto-irrigation, and harvest and kill operations. Auto-irrigation operation was selected to simulate irrigation water use from the reservoir because we did not have information about the amount of irrigation water use from Ladik Lake.

The model was run on monthly time step for the 2005-2017 period and the warm-up period was chosen as 5 years. SUFI2 algorithm was used for model calibration and validation. This algorithm available in SWAT-CUP program [19]. Monthly water volume data for Ladik Lake for the 2010-2014 period (60 months) were used for calibration and data from the 2015-2017 period (36 months) were used for validation.

$R^2$, and NSE values were 0.67, 0.66 respectively, for Ladik Lake during the calibration period. Results for the validation period was "good". $R^2$, and NSE values were 0.60, 0.58 respectively during validation. Results for the validation period was "satisfactory". The results showed that SWAT can successfully simulate the hydrological process in the Ladik Lake basin.

- ***Climate Change Scenarios***

RCP4.5 and RCP8.5 scenarios developed by MPI-ESM-MR, HadGEM2-ES, and GFDL-ESM2M Global Circulation Models outputs were used for representing future climatic conditions. These models were previously downscaled for Turkey by State Meteorology Service. The new atmospheric greenhouse gasses concentration scenarios are called "representative concentration pathways" (RCP4.5 and RCP8.5). MPI-ESM-MR, HadGEM2-ES and GFDL-ESM2M are a comprehensive Earth-System Model develop by Max Plank Institute of Germany, Hadley Centre of United Kingdom Meteorology Office, and Geophysical Fluid Dynamics Laboratory of United States respectively (Table 1). Maximum and minimum temperature and precipitation projection data were added to the model for 2021-2099 period.

*Table 2. Climate Scenarios*

| GCMs Data Set | Institution-Country | Projection Period | Spatial Resolution |
|---|---|---|---|
| MPI-ESM-MR | Max Plank Institute Meteorology-Germany | 2016-2099 | 1.865º × 1.875º |
| HadGEM2-ES | Hadley Centre of Meteorology Office - United Kingdom | 2016-2099 | 1.875º × 1.250º |
| GFDL-ESM2M | Geophysical Fluid Dynamics Laboratory-United States | 2016-2099 | 2.5º × 2.0º |

- ***Mann-Kendall***

The Mann-Kendall trend test [20] statistic (S) value is estimated at the first step Equation (1),

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} sgn\,(x_j - x_i) \quad (1)$$

In Equation (1), n gives the total number of data, x gives the individual data values, and *sgn* is a function and defined in Equation (2).

$$sgn(\theta) = \begin{cases} -1, & \theta < 0 \\ 0, & \theta = 0 \\ 1, & \theta > 0 \end{cases} \quad (2)$$

In this study a test statistics Z was accepted to be significant when p>0.05. Z defined in Equation (3).

$$Z = \begin{cases} \frac{S+1}{\sqrt{\sigma}}, \ S < 0 \\ 0, \ S = 0 \\ \frac{S-1}{\sqrt{\sigma}}, \ S > 0 \end{cases} \quad (3)$$

Mean ($\mu$) and variance ($\sigma$) are defined Equation (4) and Equation (5).

$$\mu = 0 \quad (4)$$

$$\sigma = \frac{n(n-1)(2n+5) - \sum_{i=1}^{n} t_i(t_i-1)(2t_i+5)}{18} \quad (5)$$

In this study, trends was estimated the Sen's slope method [21]. Sen's slope (Q) can be calculated using Equation (6). $Q_i$ is the slope, $x_i$ and $x_k$ are the data values at times j and k, respectively, and also j is greater than k. If there are N data in the data sets, slope (Q) calculates in Equation (7).

$$Q_i = \frac{x_j - x_k}{j-k} \qquad i = 1 \ to \ N \ and \ j > k \quad (6)$$

$$Q = \begin{cases} Q_{\left[\frac{N+1}{2}\right]}, \ N \ is \ odd \\ \frac{Q_{\left[\frac{N}{2}\right]} + Q_{\left[1+\left(\frac{N}{2}\right)\right]}}{2}, \ N \ is \ even \end{cases} \quad (7)$$

In this study used Mann-Kendall trend analysis test. Annual reservoir volume data have been processed using Mann-Kendall Trend Analysis for the determination of trend and slope magnitude during 2021 to 2098 period.

## 4.RESULTS AND DISCUSSION

### o *Precipitation, Air Temperature Changes*

Annual precipitation and average air temperature from three models under RCP4.5 and RCP8.5 scenarios for three periods 2021-2040 (near century), 2041-2070 (midcentury), and 2071-2098 (end century) are shown in Figure 2. Visual examination showed that temperature showed an upward trend in all models for all models under both RCP4.5 and RCP8.5 scenarios. In contrast, precipitation in general showed a downward trend.

Annual average air temperature and annual precipitation data of 78 years from 2021 to 2098 period were processed using Mann-Kendall Trend Test for the determination of trend (Z value) and slope (Q value) magnitude (Table 2 and Table 3).

Table 2 shows that, the detected trends for the all models under both RCP4.5 and RCP8.5 scenarios were positive (upward). MPI-ESM-MR model projected that temperatures would increase by 0.005 $^{o}$C/yr, and 0.034 $^{o}$C/yr under RCP4.5 and RCP8.5 scenarios, respectively. For the HadGEM2-ES model, the increase under RCP4.5 scenario was found to be 0.022 $^{o}$C/yr, while it was 0.057 $^{o}$C/yr under RCP8.5 scenario. The trends determined for the GFDL-ESM2M model were also positive for both scenarios. Under RCP4.5 scenario, the increase was 0.005 $^{o}$C/yr, and under RCP8.5 scenario, it was 0.034 $^{o}$C/yr. Trends in all series, except for the series for MPI-ESM-MR model, RCP4.5 scenario, were significant at the 0.05 level.

*Table 2. Trends in temperature data during the 2021-2098 period (Z-Mann-Kendall test statistic significant at the *0.05 level)*

| Climate Models for Temperature | Z Value | Q Value (Slope) ($^{o}$C/yr) |
|---|---|---|
| MPI-ESM-MR RCP4.5 | 4.51 | 0.005 |
| MPI-ESM-MR RCP8.5 | 9.36* | 0.034 |
| HadGEM2-ES RCP4.5 | 6.19* | 0.022 |
| HadGEM2-ES RCP8.5 | 9.58* | 0.057 |
| GFDL-ESM2M RCP4.5 | 1.14* | 0.005 |

| | | |
|---|---|---|
| GFDL-ESM2M RCP8.5 | 7.70* | 0.034 |

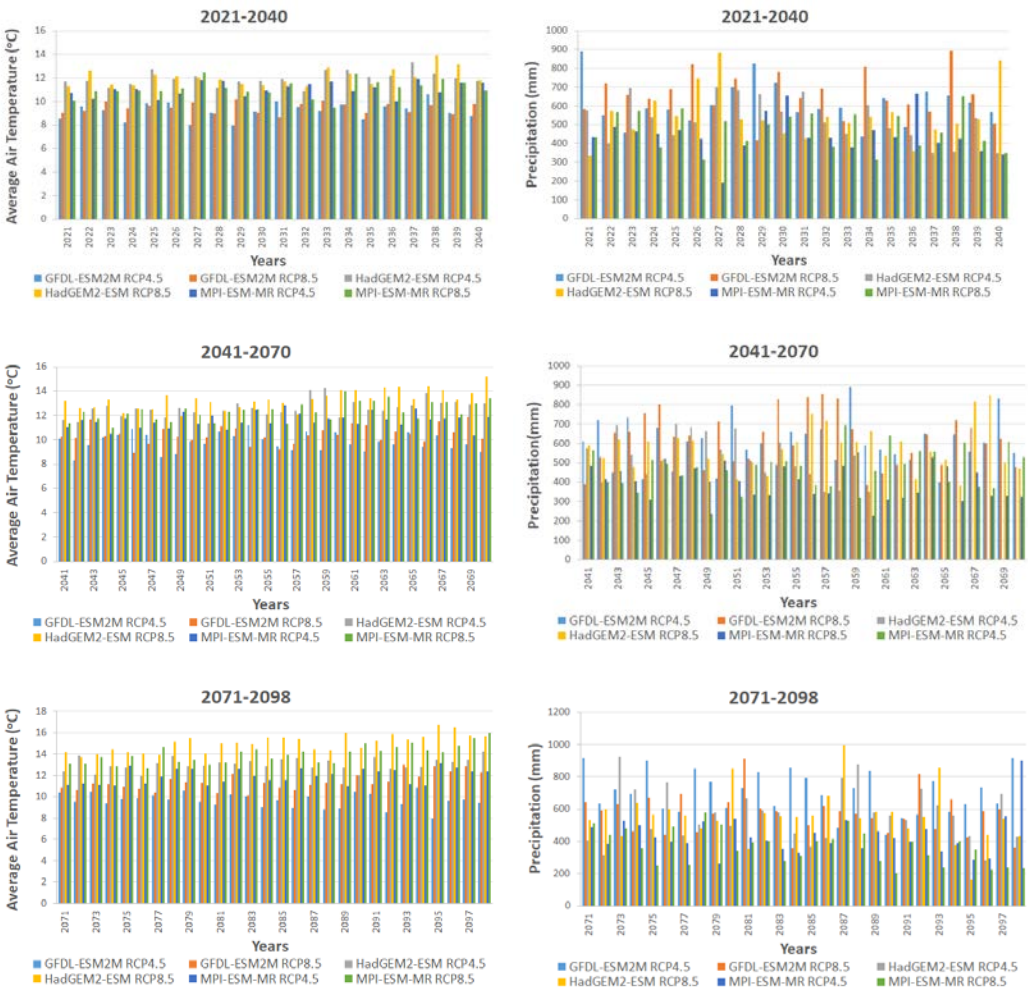


*Figure 2. Annual precipitation and average air temperature changes for 2021-2040, 2041-2070, and 2071-2098 periods.*

Trends in precipitation (Table 3) based on MPI-ESM-MR model were negative (downward) under both scenarios. The decrease under RCP4.5 scenario was -0.41 mm/yr, and it was -2.29 mm/yr under RCP8.5 scenario. The detected trends for the HadGEM2-ES model were negative (downward) under RCP8.5 scenario and negative (downward) under RCP4.5 scenario. While the rate of change under RCP4.5 scenario was -0.08 mm/yr, this value was -0.09 mm/year under RCP8.5 scenario. The trend determined for the GFDL-ESM2M model was positive under RCP4.5 scenario and negative under RCP8.5 scenario. The increase under RCP4.5 scenario was 1.53 mm/yr, and the decrease under RCP8.5 scenario was -1.70 mm/yr.

*Table 3. Trends in precipitation data during the 2021-2098 period (Z-Mann-Kendall test statistic significant at the *0.05 level)*

| Climate Models for Precipitation | Z Value | Q Value (Slope) (mm/yr) |
|---|---|---|
| MPI-ESM-MR RCP4.5 | -0.8 | -0.41 |
| MPI-ESM-MR RCP8.5 | -4.19* | -2.29 |

| | | |
|---|---|---|
| HadGEM2-ES RCP4.5 | -0.08 | -0.08 |
| HadGEM2-ES RCP8.5 | 0.15 | 0.09 |
| GFDL-ESM2M RCP4.5 | 2.30* | 1.53 |
| GFDL-ESM2M RCP8.5 | -2.77* | -1.70 |

o ***Climate Change Effects on Reservoir Volume***

Annual reservoir volume data of 78 years from 2021 to 2098 period were processed using Mann-Kendall Trend Test for determination of trend (Z value) and slope (Q value) magnitude (Table 4). The detected trends for the GFDL-ESM2M model were positive (upward) under RCP4.5 scenario and negative (downward) under RCP8.5 scenario. While the rate of change under RCP4.5 scenario was 233 $m^3$/yr, this value was -77885 $m^3$/yr under RCP8.5 scenario. The trends determined for the HadGEM2-ES model were negative under both RCP4.5 and RCP8.5 scenarios. The decrease under RCP4.5 scenario was -1111 $m^3$/yr, and the decrease under RCP8.5 scenario was -1786 $m^3$/yr. For the MPI-ESM-MR model, the detected trends were negative under both RCP4.5 and RCP8.5 scenarios. The decrease under RCP4.5 scenario was found to be -126620 $m^3$/yr, while the decrease under RCP8.5 scenario was -273806 $m^3$/yr. Ladik Lake volume decreased in most of the models and scenarios, except for the GFDL-ESM2M model RCP4.5 scenario.

*Table 4. Trends in reservoir volume data in Ladik Lake during 2021-2098 period (Z-Mann-Kendall test statistic significant at the *0.05 level)*

| Climate Models for Reservoir Volume | Z Value | Q Value (Slope) ($m^3$/year) |
|---|---|---|
| MPI-ESM-MR RCP4.5 | -2.14* | -126619 |
| MPI-ESM-MR RCP8.5 | -5.55* | -273806 |
| HadGEM2-ES RCP4.5 | -0.13 | -1111 |
| HadGEM2-ES RCP8.5 | -0.63 | -1786 |
| GFDL-ESM2M RCP4.5 | 0.72 | 233 |
| GFDL-ESM2M RCP8.5 | -3.74* | -77885 |

## 5.CONCLUSIONS

Ladik Lake is a natural lake and an ecologically important site in Turkey. In recent years, water level changes in the lake raised concerns regarding its future hydrological and ecological characteristics. In this study, we examined climate change impacts at Ladik Lake. We used a basin-scale hydrological model, develop using Soil and Water Assessment Tool (SWAT) for simulating future hydrologic conditions.

RCP4.5 and RCP8.5 scenarios develop by MPI-ESM-MR, HadGEM2-ES, and GFDL-ESM2M Global Circulation Models outputs were used for representing future climatic conditions. These models were previously downscaled for Turkey by the State Meteorology Service.Annual average air temperature, precipitation, and reservoir volume data of 78 years from 2021 to 2098 period has been processed using Mann-Kendall Trend Analysis for the determination of trend (Z value) and slope (Q value) magnitude.

Air temperature values showed an upward trend and precipitation showed a downward trend based on majority of the models/scenarios. Ladik Lake volume decreased in most of the models and scenarios, except for the GFDL-ESM2M model RCP4.5 scenario. The results showed that Ladik Lake's water volumes are very sensitive to future climatic changes.

## ACKNOWLEDGMENT

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# Groundwater Vulnerability Mapping Using DRASTIC Model: A Case Study at the Palas Basin in Turkey

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***Abstract***

*The study aims to estimate groundwater vulnerability against pollution at the Palas Basin (Turkey) by using geographical information system based DRASTIC model. A DRASTIC model integrates information for seven hydrogeological parameters: depth to water (D), net recharge (R), aquifer media (A), soil media (S), topography (T), impact of vadose zone (I), and hydraulic conductivity (C), and identifies spatial vulnerability. The study area, Palas Basin, is a hydrologically closed, agricultural basin, where groundwater is used for meeting irrigation and municipal water requirements. Seven hydrogeological parameters were combined to classify the basin into three vulnerable zones (as low, medium, and high). The central part of the basin was identified to be highly vulnerable, while the eastern and southern parts were characterized by moderate to low vulnerable areas. Intensive agricultural activities, widespread in the central basin, create high pollution potential. This study showed that the DRASTIC approach provided a simple and efficient tool for evaluating groundwater vulnerability. The results can be used by water managers in groundwater management in the Palas Basin.*

**Keywords:** Aquifer Vulnerability, DRASTIC, GIS, Palas Basin

## 1.INTRODUCTION

Freshwater resources are limited and not equally distributed throughout the world. Human activities and climate change also pose direct or indirect impacts on scarce freshwater resources [1;2]. The number of countries experiencing water scarcity and the population that can reach sufficient amount of water decrease [3;4;5] and water stress increases [6;7]. It is, therefore, crucial to use existing water resources efficiently.

Vulnerability modeling approaches can help determine how vulnerable groundwater is to various stresses. DRASTIC is a geographic information system (GIS) based model that can be applied to shallow groundwater systems [8]. In this method, it is assumed that all pollutants in the basin can infiltrate, be transported, and dissolved in groundwater [8]. Thus, by determining the potential effects of pollutants in the basin, regions susceptible to pollution can be determined. DRASTIC based vulnerability maps can be used in groundwater planning, especially in agricultural basins. The information obtained plays a role in planning activities such as water use, agricultural land use planning, animal husbandry, and fertilization.

In this study, we estimated groundwater vulnerability against pollution at the Palas Basin in Turkey. This basin is a hydrologically closed basin where intensive irrigated agriculture takes place. Irrigation and drinking water requirements in the basin are almost entirely met from groundwater. Agricultural activities can pose threats for groundwater quality. In this study, we aim to show how vulnerable is the groundwater system to pollution.

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## 2.METHODS

### o *Study Area*

This study was carried out at the Palas Basin (Figure 1). Palas Basin is an agricultural basin, located in Kayseri, in the Central Anatolia Region of Turkey. The basin is a hydrologically closed basin plain. The altitude of the region is from 1131 to 2119 meters, and its area is approximately 100 km$^2$ [9]. Tuzla Lake is located to the west of the basin. Tuzla Lake is an ecologically important area as it is located in the junction point of migration routes of birds migrating from Asia, Europe and Africa and hosts endemic plant species [10]. A small stream, named Değirmen Stream, flows towards Tuzla Lake by joining two branches from Koyunabdal and Kahveci locations. The flow in the stream is very low and it is mostly dry during summer months. Therefore, the major water source in the basin is groundwater. Groundwater is used for meeting irrigation and drinking water requirements.

Economic activities in the region are agriculture, animal husbandry, and salt extraction. The average annual air temperature of the Palas Basin is 11°C. The hottest month is July, where the average temperature is 20ºC. In January, the coldest month, the average air temperature is -2.5ºC. Average annual precipitation is 402 mm. [9].

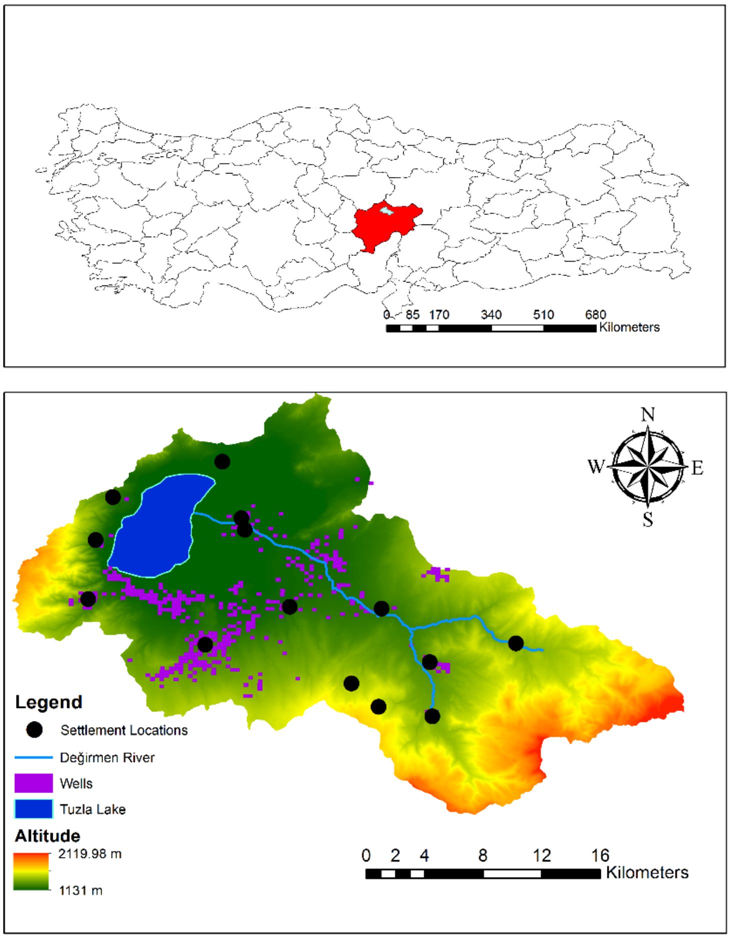


*Figure 1: Study area representation*

Groundwater in the Palas Basin can be vulnerable to pollution due to intensive agricultural activities taking place in the basin. Nitrate concentrations in groundwater are already high in some parts of the basin. Groundwater levels are also decreasing as a result of intensive use of groundwater. The change in groundwater salinity can be a problem due to the interaction of the saline Tuzla Lake with groundwater in the region [10].

o ***DRASTIC Method***

The DRASTIC method basically uses seven hydrogeological factors to assess the susceptibility of groundwater to contamination. The DRASTIC parameters' weights, defined according to Aller et al. [8], range from 1 to 5 (Table 2). The most important parameter is given weight 5 and the least important parameter is given weight 1. The weights are chosen depending on the parameters affecting the spread of the pollutants. In addition, each parameter is divided into degrees according to its pollution potential. The degrees are determined according to rating classes in layers and the impact rating values of that layer are determined. Later, these layers were combined according to their weight values and the DRASTIC index layer was created. Mathematical model equation for the DRASTIC index is given in Eq. 1.

$$DI = \sum_{i=1}^{7}(W_i * R_i) \quad (1)$$

In Equation 1, the variable "$i$" denote the layers such as Depth to Water (D), Net Recharge (R), Aquifer Media (A), Soil Media (S), Topography (T), Impact of Vadose Zone (I), Hydraulic Conductivity (C). Also "W" variable is weighted number for each layer, "R" variable is rating number for each by "i" layer class. Finally, "DI" is the DRASTIC Index. The summary of the raw data sources and the operations applied for the "i" layers obtained are given in Table 1. Also, the weighted values and rating values selected according to the literature are given in Table 2.

*Table 1: Summary of the raw data sources and the operations applied for the DRASTIC layers*

| Layers | Raw Data Source | Data Adjustments |
|---|---|---|
| Depth to Water | Log Data for Different Location at Basin | * Coordinate transformation<br>* GRID installation (100mx100m)<br>*Classification |
| Net Recharge | SWAT Model | * Coordinate transformation<br>* GRID installation (100mx100m)<br>*Classification |
| Aquifer Media | State Hydraulic Works | * Coordinate transformation<br>* GRID installation (100mx100m)<br>*Classification |
| Soil Media | FAO World Soil Map | * Image Clip Process<br>* Coordinate transformation<br>* GRID installation (100mx100m)<br>*Classification |
| Topography | Using DEM image by SRTM Satellite | * Image Clip Process<br>* Coordinate transformation<br>* GRID installation (100mx100m)<br>*Slope Analysis<br>*Classification |
| Impact of Vadose Zone | FAO World Soil Map | * Image Clip Process<br>* Coordinate transformation<br>* GRID installation (100mx100m)<br>*Classification |
| Hyraulic Conductivity | SPAW Hydrology Programme | *Hydraulic Conductivity Values Search and Input for Soil Types<br>* Coordinate transformation<br>* GRID installation (100mx100m)<br>*Classification |

*Table 2: Weights and ratings assigned to seven parameters used in the DRASTIC vulnerability index modelling*

| Parameter | Classes | Rating | Weight |
|---|---|---|---|
| Depth to Water (m) | 0-1.5 | 10 | 5 |
| | 1.5-4.6 | 9 | |
| | 4.6-9.1 | 7 | |
| | 9.1-15.2 | 5 | |
| | 15.2-22.9 | 3 | |
| | 22.9-30.5 | 2 | |
| | >30.5 | 1 | |
| Net Recharge (m/year) | 0-141 | 1 | 4 |
| | 141-282 | 3 | |
| | 282-494 | 6 | |
| | 494-705 | 8 | |
| | >705 | 9 | |
| Aquifer Media | Silty Clay, Sand, Gravel | 4 | 3 |
| | Sandstone | 6 | |
| | Siltstone, sandstone, clay limestone | 6 | |
| | Silty clay | 7 | |
| | Broken cracked rock | 3 | |
| | Impervious tuffs | 9 | |
| Soil Media | Sandy clay loam | 2 | 2 |
| | Clay silty | 3 | |
| | Silty clay loam, sandy clay loam, clay loam | 4 | |
| | Sandy clayey gravelly | 6 | |
| | Fine sandy loam - sandy loam | 8 | |
| | Clay - silty clay - sandy clay | 2 | |
| Topography (percent) | 0-2 | 10 | 1 |
| | 2-6 | 9 | |
| | 6-12 | 5 | |
| | 12-18 | 3 | |
| | >18 | 1 | |
| Impact of Vadose Zone | Sandy clay loam | 2 | 5 |
| | Clay silty | 3 | |
| | Silty clay loam, sandy clay loam, clay loam | 4 | |
| | Sandy clayey gravelly | 6 | |
| | Fine sandy loam - sandy loam | 8 | |
| | Clay - silty clay - sandy clay | 2 | |
| Hyraulic Conductivity (m/day) | 0.19 | 1 | 3 |
| | 0.21 | 1 | |
| | 0.18 | 1 | |
| | 0.23 | 1 | |
| | 0.24 | 1 | |
| | 0.27 | 1 | |

## 3.RESULTS

Seven hydrogeological parameters were combined to create the drastic index map for the Palas Basin. Figure 2 presents each layer and their categories. Here, the depth to water layer is the distance of the groundwater aquifer from the surface. As this distance decreases, groundwater becomes more vulnerable to pollutants. Depth to water layer values were divided into seven categories according to Aller et. al. [8]. Another layer is the net recharge layer. The increase in the net recharge value in this layer means that the groundwater is more vulnerable for potential contamination. Net recharge values were obtained from a previously developed SWAT model and classified into three [11]. In the study, aquifer media is divided into 6 classes. In the aquifer media variable, contamination potentials may increase or decrease depending on the permeability of aquifer materials. A similar situation is valid for the soil media and impact of vadose zone. In the topography layer, the contamination potential changes depending on the slope. As the slope value increases, the leakage into the groundwater will decrease, so a low pollution rating value is stated. As the slope value decreases, the contamination potential degree increases as the water flow will go towards leakage. Finally, in the hydraulic conductivity variable, the increase in conductivity value is the effect that increases the potential for groundwater contamination. When the conductivity value increases, the rating value of the variable class also increases.

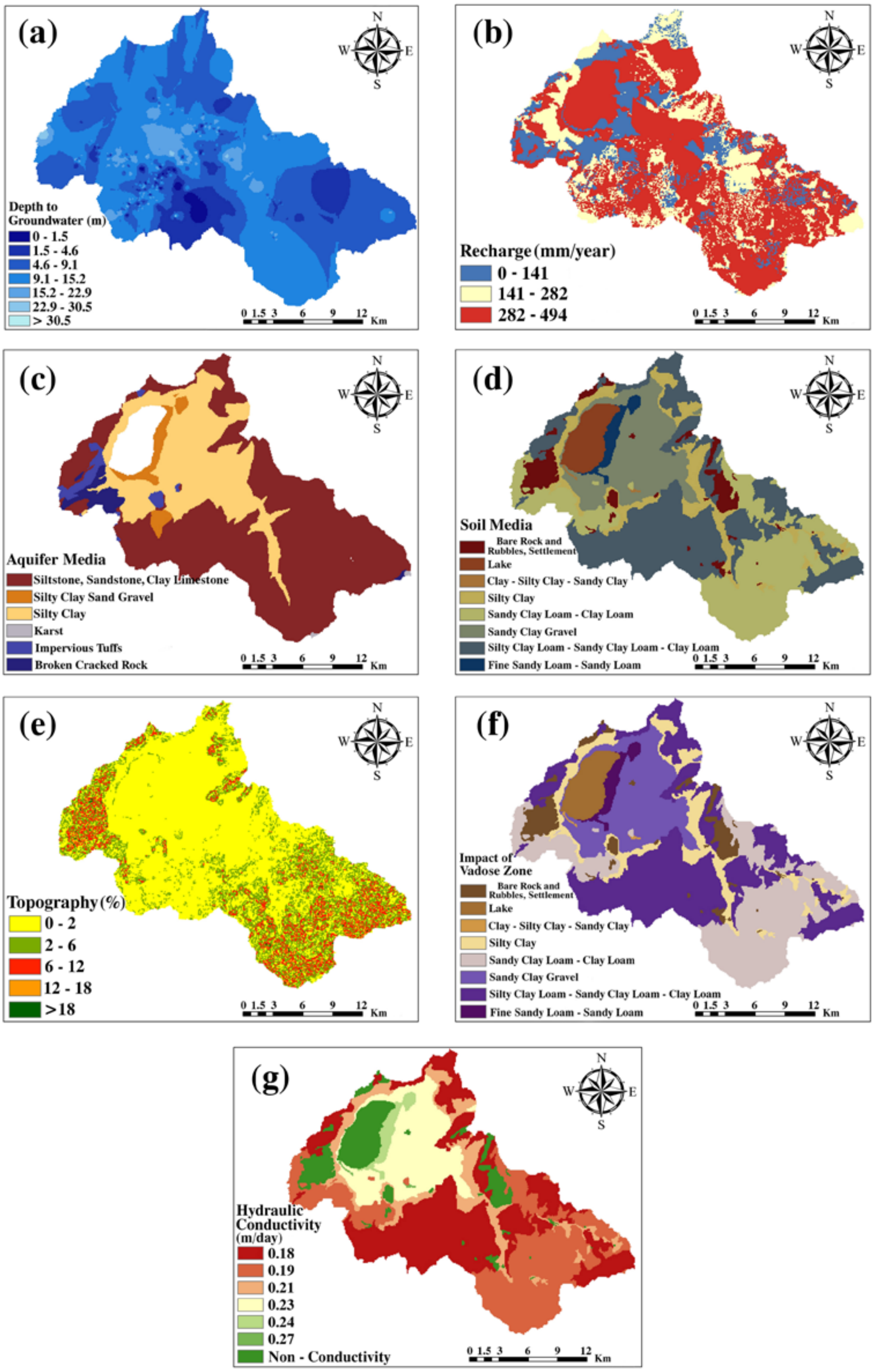


*Figure 2: DRASTİC layers and classes of each layer*

DRASTIC Index map was created by combining seven separate layers (Figure 3). In this map, a numerical output value was created for each grid value and these values were divided into three classes as low, moderate and high vulnerability zones.

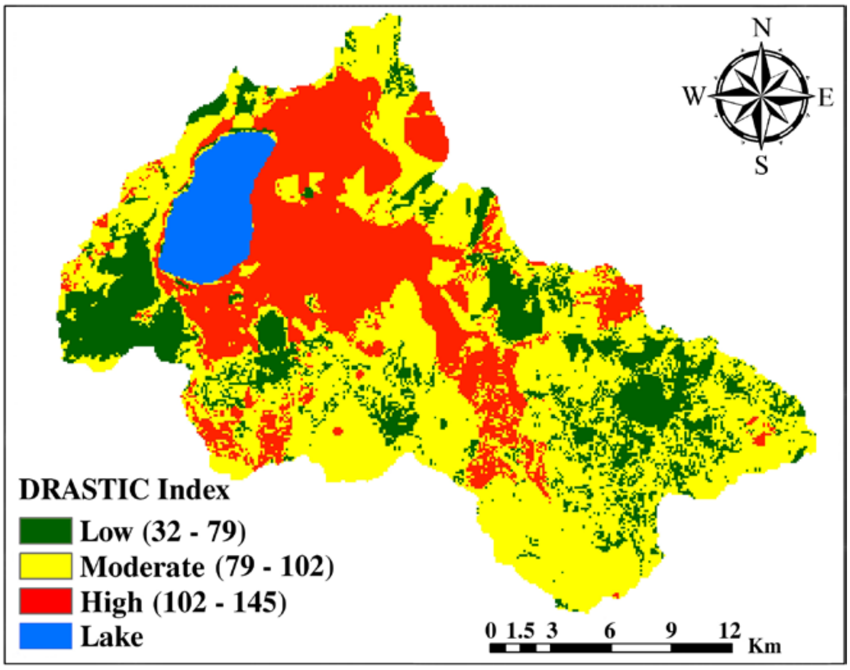


*Figure 3. Drastic index map for Palas Basin*

According to Figure 3, majority of the basin is covered by moderate vulnerability class (60%). Low vulnerability zone covers 17% and high vulnerability zone covers 23%. However, the areas with high vulnerability are located in the region where agricultural activities are intense and settlements are located. This situation creates a potential risk for groundwater quality. Therefore, the use of chemicals such as fertilizers and pesticides in the region should be strictly controlled.

## 4.CONCLUSION

This study was conducted for groundwater vulnerable assessment in the Palas Basin. DRASTIC model with inputs for depth to water (D), net recharge (R), aquifer media (A), soil media (S), topography (T), impact of vadose zone (I), and hydraulic conductivity (C) were used to estimate spatial vulnerability of Palas Basin. Vulnerability studies reflect the potential for contamination of the region's groundwater. As a result of the study, approximately 23% of the groundwater in the basin was determined to be highly vulnerable to pollution. The data obtained in this study can be used for comparison with actual pollution values or to determine the effects of land use changes on the basin.

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# Climate Change Impacts on Potential Groundwater Recharge in the Palas Basin, Turkey

***Mehmet Soylu[1], Filiz Dadaser-Celik[2]***

***Abstract***

*Climate change poses a major threat for sustainability of groundwater resources. In this study, we aimed to determine how climate change can affect groundwater recharge potential in the Palas Basin. Palas Basin is a semi-arid closed basin located in Kayseri, in the central Anatolia region of Turkey. Agriculture is the major economic activity in the region and groundwater is used extensively for irrigation purposes. In this study, we estimated potential groundwater recharge for the Palas Basin under two representative concentration pathway (RCP) scenarios (RCP4.5 and RCP8.5) projected by HadGEM2-ES, MPI-ESM-MR, GFDL-ESM2M global climate models. All models projected a decrease in mean annual potential groundwater recharge under the RCP8.5 scenario. Under the RCP4.5 scenario, the trends in annual potential groundwater recharge were negative according to the HadGEM2-ES, MPI-ESM-MR models but slightly positive according to the GFDL-ESM2M model. For sustainability of the groundwater system and agricultural activities in the basin, climate change adaptation strategies should be developed for the agricultural sector.*

**Keywords:** Climate Change Effects, Groundwater Potential Recharge Change, Palas Basin

## 1.INTRODUCTION

Water resources sector is among the major sectors to be affected by climate change. Changes in climatic conditions can affect hydrologic characteristics of both surface waters and groundwater [1;2]. These changes, in turn, cause other effects such as the reduction of biological diversity, water quality changes, etc.

The effects of climate change on groundwater recharge have been investigated in a number of studies [3]. Net recharge and potential recharge were estimated based on climate projections. These studies showed that precipitation changes were mostly responsible for decreases or increases in groundwater recharge. Majority of the studies predicted a decrease in groundwater recharge [4;5;6;7]. Some other studies examined the effects of changes in evapotranspiration and land cover [7]. Increases in evapotranspiration and land cover changes, which increased impervious areas, also projected to cause decreases in groundwater recharge.

Turkey is among the countries, expected to be adversely affected by climatic changes. Turkey has diverse climatic conditions, changing from Mediterranean along the coasts to continental in central regions. Regions with different climatic characteristics can respond differently to climatic changes [8]. In coastal areas, changes in precipitation patterns can cause changes in frequency flood events [9;10]. In central regions, where continental climate prevails, decreases in precipitation can increase the frequency of droughts [10;11;12]. Previous studies showed that downward trends in precipitation have already been detected in central regions and these trends are expected to continue in the future [13]. The decreases in precipitation could affect the groundwater recharge [14]. The reductions in groundwater recharge, in turn, can have negative impacts on the agricultural sector and on groundwater-dependent ecosystems [9;10].

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In this study, we examined the changes in potential groundwater recharge due to climate change in the Palas Basin, Kayseri, Turkey. We estimated potential groundwater recharge by considering hydrogeological characteristics of the Palas Basin and precipitation projections for the future. Precipitation projections developed with three global circulation models (HadGEM2-ES, MPI-ESM-MR, GFDL-ESM2M) under RCP4.5 and RCP8.5 scenarios were used in the analyses. This analysis can show the sensitivity of groundwater to climate change in the Palas Basin and in other semi-arid regions.

## 2.METHODS

### o *Study Area*

This study was conducted in the Palas Basin, located in Kayseri, Turkey (Figure 1). The basin is a closed basin where the elevation changes between 1131 and 2120 m above sea level [15]. The average altitude of the basin is 1336 meters and it covers an area of approximately 100 km$^2$ [15].

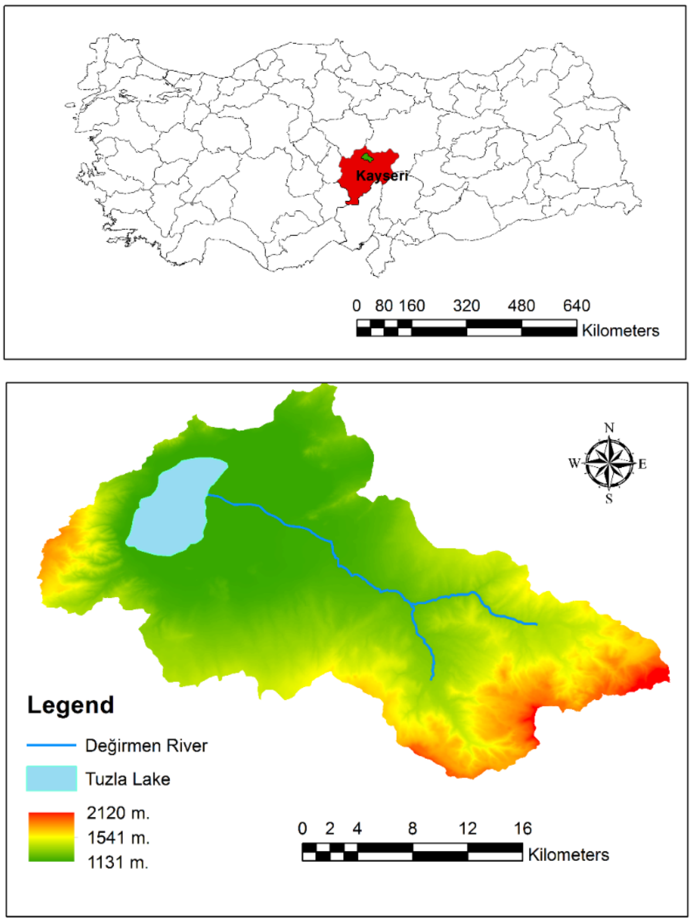


*Figure 3. Location and physical and topographical characteristics of the Palas Basin*

Figure 2 shows the geological characteristics of the Palas Basin. Mesozoic ophiolitic complex, sedimentary rocks, Mesozoic aged magmatic rocks, Eocene and Neogene aged sediments, Plio Quaternary clayey silty fine-grained sediments, Quaternary slope accumulation and alluviums can be identified in the figure. In general, geological formations in the Palas Basin can be divided into three main groups. These are Quaternary alluviums in the lake and its immediate surroundings, Tertiary aged formations spread over a wide area in the east of the basin and Mesozoic formations located in a narrow area in the southwest of the basin.

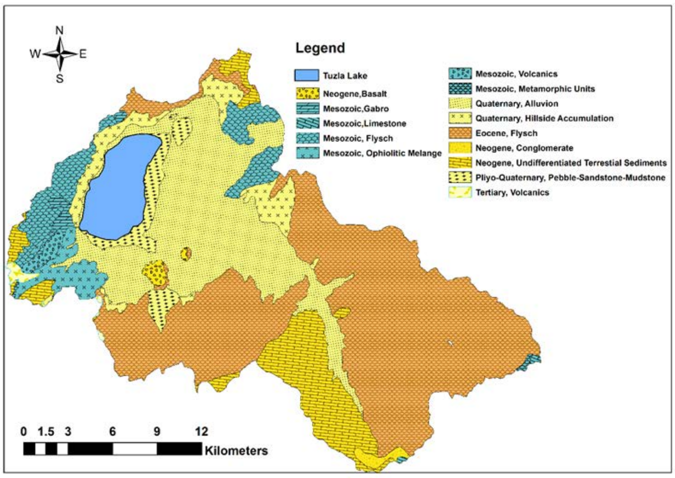


*Figure 4. Geological characteristics of the Palas Basin [16]*

The climate is semi-arid with an annual average temperature of about 11°C and the annual precipitation of 400 mm. Surface water resources are scarce in the basin. There is small stream, Değirmen River, flows from southeast to northwest and discharges into Tuzla (Palas) Lake, located to the west of the basin. In summer months, the stream becomes completely dry and is lost before reaching the lake. Tuzla Lake is a saline playa lake, fed by rainfall and surface and groundwater flows. It is the second largest saline lake in Turkey and is a nature conservation area due to ecological characteristics.

Agriculture is the major economic activity in the region and other economic activities are animal husbandry and salt extraction. Groundwater is the major water source used for irrigation activities in the region. In irrigated areas, maize, sugar beets and vegetables are cultivated. Cereals are common in unirrigated areas.

### o *Estimating Potential Groundwater Recharge*

Potential groundwater recharge was estimated according to Equation 1, based on lithological classes and precipitation.

$$R=\sum_{i=1}^{n} PA_i I_i \quad (1)$$

In Equation 1, R is expressed as the potential recharge ($m^3$/year), A is the area of each lithological unit (I) ($m^2$), P is the annual precipitation (m/year), n is the total number of lithological units. I represents the percolation coefficient for each lithological unit. The area of each lithological unit was estimated from the geological map given in Figure 1. The percolation coefficients for each lithological unit was estimated as given in Table 1 [16].

*Table 3. Lithological units, their areal coverages and percolation coefficients [16]*

| Lithological Class | Area ($km^2$) | Lithological Percolation |
|---|---|---|
| Quaternary, Alluvium | 105.18 | 0.15 |
| Quaternary, Hillside Accumulation | 9.15 | 0.05 |
| Pliyo-Quaternary, Pebble, Sandstone, Mudstone | 5.62 | 0.10 |
| Neogene, Basalt | 2.27 | 0.10 |
| Neogene, Unconsolidated Terrestrial Sediments | 15.99 | 0.05 |
| Eocene, Flysch | 59.64 | 0 |
| Mesozoic, Flysch | 5.80 | 0 |

| | | |
|---|---|---|
| Mesozoic, Ophiolitic Melange | 0.13 | 0 |

o *Climate Projections*

We obtained precipitation projections with daily timescale from the Turkish State Meteorological Service (MGM). MGM produced downscaled precipitation data by using data from three Global Circulation Models, GFDL-ESM2M, HadGEM2-ES and MPI-ESM-MR, for two representative concentration pathways (RCPs): RCP 4.5 and RCP 8.5. The data were downscaled with the RegCM4.3.4 Regional Model by MGM based on 1971-2000 reference period [17]. GFDL-ESM2M model is produced by Geophysical Fluid Dynamics Laboratory (United States) with a resolution of 2.5° × 2.0°. HadGEM2-ES models is produced by Met Office Hadley Centre (United Kingdom). It has resolution of 1.875° × 1.250°. MPI-ESM-MR is run by Max Plank Institute (Germany) with 1.865◦×1.875◦ resolution. The RCP 4.5 assumes that greenhouse gas concentration will peak around 2040, then decline from the mid-century, while the RCP8.5 assumes that greenhouse gas concentration increasing until the 21st century. The projections for the 2021-2098 period were used in the analyses.

## 3.RESULTS

In this study, potential recharge for groundwater was calculated for the 2021-2098 period based on RCP4.5 and RCP8.5 scenarios from HadGEM2-ES, MPI-ESM-MR, GFDL-ESM2M models. RCP4.5 was the scenario with lower carbon emissions on a global scale and it is scenario targeted globally. RCP8.5, on the other hand, is the scenario with higher carbon emissions and farther from the target point.

Below we first present projected precipitation changes with RCP4.5 and RCP8.5 scenarios with HadGEM2-ES, MPI-ESM-MR, GFDL-ESM2M models. Then, we discuss projected changes in potential groundwater recharge.

o *Changes in Precipitation from 2021 to 2098*

Annual precipitation data estimated based on RCP4.5 and RCP8.5 scenarios from 2021 to 2098 with HadGEM2-ES, MPI-ESM-MR, GFDL-ESM2M models were shown in Figure 3.


*Figure 5. Annual precipitation changes from 2021 to 2098*

We estimated the trends in precipitation series using the linear regression method. According to the HadGEM2-ES and MPI-ESM-ER models, downward trends were detected under both RCP4.5 and RCP8.5 scenarios. GFDL-ESM2M model estimated a slightly positive trend under the RCP4.5 scenario but downward trend under the RCP8.5 scenario. The trends detected for RCP8.5 scenarios with GFDL-ESM2M and MPI-ESM-ER models were statistically significant at the 0.01 level.

*Table 4. Trends in precipitation series estimated using linear regression method and their statistical significance*

| Precipitation | RCP4.5 | | RCP8.5 | |
|---|---|---|---|---|
| | Trend (mm/year) | P Value | Trend (mm/year) | P Value |
| HadGEM2-ES | -0.26 | 0.558 | -0.75 | 0.126 |
| MPI-ESM-ER | -0.80 | 0.062 | -1.55 | 0.002 |
| GFDL-ESM2M | 0.11 | 0.851 | -1.51 | 0.002 |

Also, in addition to the analysis of a single data set, we also analyzed precipitation data in shorterm, midterm and longterm periods. Accordingly, the obtained are as follows;

Compared to the 2021-2040 period, mean annual precipitation is predicted to decrease by 46.9 mm (%8.67) (GFDL-ESM2M), 1.7 mm (%0.35) (HadGEM2-ES), and 25.3 mm (%5.01) (MPI-ESM-ER) during the 2041-2070 period according to the RCP4.5 scenario. The decrease would be 0.1 mm (%0.02) (GFDL-ESM2M) and

42.3 mm (%9.11) (MPI-ESM-ER) from the 2021-2040 to the 2071-2098 period. HadGEM2-ES estimated a slight increase of 12.3 mm (%2.54) in the 2071-2098 period compared to the 2021-2040 period.

According to the RCP8.5 scenario, mean annual precipitation during the 2041-2070 period would decrease by 33.8 mm (%5.80) (GFDL-ESM2M), 29.6 mm (%5.80) (HadGEM2-ES), and 66.1 mm (%13.50) (MPI-ESM-ER) compared to the 2021-2040 period. GFDL-ESM2M, HadGEM2-ES and MPI-ESM-ER predicted that the annual precipitation would be 82.17 mm (%14.20), 32.86 mm (%6.4), 89.9 mm (%18.40) lower during the from 2021-2040 to 2071-2098 period. As can be seen from these results, precipitation predicted with RCP8.5 scenarios are lower than those predicted by RCP 4.5 scenarios.

### o *Changes in Potential Groundwater Recharge from 2021 to 2098*

Precipitation values produced by three models, GFDL-ESM2M, HadGEM2-ES and MPI-ESM-ER, were used as input for estimating potential recharge under RCP4.5 and RCP8.5 scenarios.

*Table 5. Trends in annual potential groundwater recharge series estimated using linear regression method and their statistical significance*

| Potential Recharge | RCP4.5 | | RCP8.5 | |
|---|---|---|---|---|
| | Trend ($m^3$/year) | P Value | Trend ($m^3$/year) | P Value |
| HadGEM2-ES | -4063 | 0.572 | -14767 | 0.087 |
| MPI-ESM-ER | -13901 | 0.092 | -25580 | 0.002 |
| GFDL-ESM2M | 2999 | 0.784 | -26828 | 0.002 |

Also changes in potential groundwater recharge from 2021 to 2098 were shown in Figure 4.

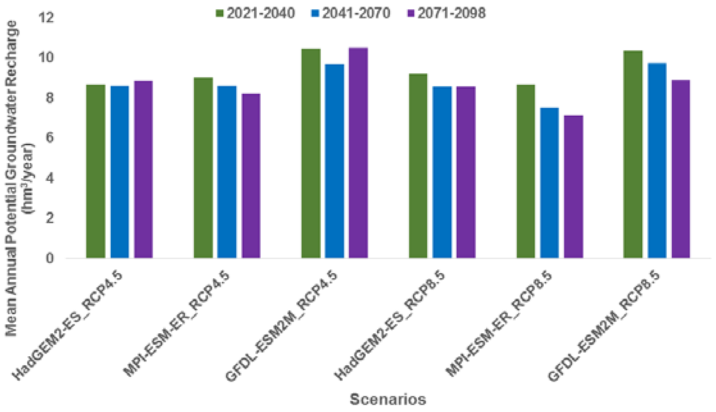


*Figure 6. Potential groundwater recharge under the RCP4.5 and RCP8.5 scenarios*

Compared to the 2021-2040 period, mean annual potential groundwater recharge is predicted to decrease by 0.78 $hm^3$ (%7.42) (GFDL-ESM2M), 0.09 $hm^3$ (%1.02) (HadGEM2-ES), and 0.44 $hm^3$ (%4.87) (MPI-ESM-ER) during the 2041-2070 period according to the RCP4.5 scenario. The increase would be 0.02 $hm^3$ (%0.23) (GFDL-ESM2M), 0.18 $hm^3$ (%2.13) (HadGEM2-ES) and decrease 0.80 $hm^3$ (decrease %8.87) (MPI-ESM-ER) from 2021-2040 to during the 2071-2098 period.

According to the RCP8.5 scenario, from 2021-2040 to 2041-2070, the average annual potential groundwater recharge variation decrease 0.61 $hm^3$ (5.90%) (GFDL-ESM2M), decrease 0.62 $hm^3$ (6.70%) (HadGEM2-ES) and decrease 1.11 $hm^3$ (12.80%) (MPI-ESM-ER). In the RCP 8.5 scenario, the decrease from 2021-2040 to 2071-2098 is 1.47 $hm^3$ (14.20%) (GFDL-ESM2M), 0.65 $hm^3$ (7.10%) (HadGEM2-ES), 1.50 $hm^3$ (17.40%) (MPI-ESM-ER). Figure 4 also shows that potential groundwater recharge values in the RCP4.5 scenario in GFDL-ESM2M and MPI-ESM-ER projections are higher than those in the RCP8.5 scenario.

We estimated the trends in annual potential groundwater recharge series using the linear regression method. According to HadGEM2-ES and MPI-ESM-ER models downward trends were detected both under the RCP4.5 and RCP8.5 scenarios. GFDL-ESM2M model estimated a slightly positive trend under RCP4.5 scenario but downward trend under RCP8.5 scenario. The trends detected for the RCP8.5 scenario with GFDL-ESM2M and MPI-ESM-ER models were statistically significant at the 0.01 level.

## 4.CONCLUSION

In this study we used precipitation projections by three different global circulation models – GFDL-ESM2M, HadGEM2-ES and MPI-ESM-ER to understand how potential groundwater recharge can change in a semi-arid agricultural basin from 2021 to 2098. The analyses were based on two RCP scenarios; RCP4.5 and RCP8.5. RCP4.5 scenario can be defined as a scenario where the factors triggering global warming are more under control. Two models HadGEM2-ES and MPI-ESM-ER projected a downward trend in potential groundwater recharge values from 2021 to 2098 under RCP4.5 scenario. Only GFDL-ESM2M projected a slight upward trend only under the RCP4.5 scenario. RCP8.5 scenario assumes a situation where the factors triggering global warming are more intense. Under the RCP8.5 scenario, the annual potential recharge values went down from 2021 to 2098 and the downward trends were much stronger than the ones detected with the RCP4.5 scenario.

As a result, groundwater potential recharge values are expected to decrease in the Palas Basin. A reduction in potential groundwater recharge means that the groundwater used for agricultural purposes will become more limited. This situation can have social and economic consequences for the region such as increase in migration. Groundwater is also important for the Tuzla Lake ecosystem. A decrease in precipitation and groundwater recharge can have adverse effects on the hydrological and ecological characteristics of Tuzla Lake ecosystem.

In order to maintain the hydrological balance in the region under changing climatic conditions, measures should be taken to reduce water use in irrigation. This can be achieved by changing irrigation technologies and crop types or using different irrigation scheduling and water saving technologies. The results obtained in this study can be helpful for more comprehensive studies such as net recharge calculation, surface water modeling, socio-economic modeling.

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## BIOGRAPHY

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# Synthesis and Characterization of a Natural Cellulose Product from Biowaste

***Mehmet Kaya*[1]**

***Abstract***

*In recent years, there has been a significant increase in agricultural wastes in the world in parallel with the changing economic conditions and increasing demand-consumption. Despite this size in the production of agricultural products, there is a serious agricultural waste that cannot be evaluated economically, is a source of biomass and bioenergy, and can be input to bio-products. By utilizing this natural product, cellulose - sourced wastes, biomass will be recovered beneficially, new and low-cost industrial bioproducts will be produced and brought into the economy. In this context, the transformation of the factory wastes of the tea plant, which is an important cellulose source, into a product called "cellulose aerogel" and the characterization of this product constitute the main purpose of this study. In line with the purpose, the following objectives were achieved by taking cellulose, a natural polymer, obtained from agricultural waste, into the center;*

** To isolate cellulose from factory wastes of tea plant produced in Rize city in Turkey,*
** To obtain cellulose hydrogel by dissolving cellulose in NaOH / Urea cold (-12 ° C) solution,*
** To obtain a gel with the solvent exchange of the cellulose solution in various solvent environments.*
** As a result of solvent change, to increase the durability of the material called "solvogel" by protecting the cellulose molecular skeleton structure.*
** To obtain "cellulose aerogel" which is a porous and durable product by drying the solvogel with lyophilization (freeze drying) method,*
** To carry out the characterization of the cellulose aerogel obtained by various methods.*

**Keywords:** Cellulose, Aerogel, Bio-waste, Freeze-Drying.

## 1.INTRODUCTION

Aerogel is a very light, porous, heat and weight resistant solid material obtained by replacing the liquid structure of the gel with air. Aerogels are produced from ordinary gels by supercritical drying or low-pressure freeze-drying processes. During these processes, the ambient pressure is suddenly reduced, allowing the material in this phase to acquire a porous structure. Aerogels; Thanks to its superior properties such as low density, high porosity, and large specific surface area, it has the potential to be used in many application areas. Aerogels; acoustic barrier, thermal insulation material, adsorbent, catalyst, energy storage, aviation materials, medical supplies, etc. used in the fields. There are many studies on aerogels, and with these studies, aerogels answer a new problem every day. However, the search for a cheaper and more efficient aerogel production continues, since the production costs are high due to the raw material used, complex and long process steps and the energy consumed in the current technique. Scientific studies in this area have recently focused on the production of cellulose-derived aerogels [1-4].

There are many studies in today's literature focused on cellulose, which is the most abundant biopolymer product in nature. Cellulose material has an important place among natural reinforcing elements. Cellulose microfibrils can be separated from many different sources by mechanical and chemical treatments. Depending on the source, these cellulose fibrils can be about 5 to 10 nm in diameter and from 100 nm to hundreds of micrometers in length. Each fibril contains crystalline and amorphous regions. These amorphous regions are dissolved by acid hydrolysis and crystalline regions, namely cellulose nanocrystallites, remain [5-19]. It is shown representatively in Figure 1. The

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variety of modifications that can be made in the unique structure of cellulose polymer, which is a macromolecule, provides significant advantages in application areas.

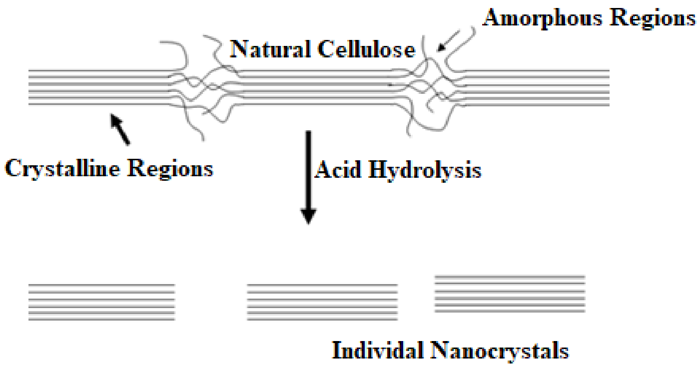


*Fig. 1. Obtaining cellulose nanocrystallite from natural cellulose*

The production and characterization of a highly flame retardant, environmentally friendly, superabsorbent, and biocompatible cellulose aerogel is described here. The cellulose used in the present study was largely isolated from agricultural biological wastes, which is a source of factory tea waste produced annually. The superabsorbent and flame retardant properties and structural, morphological, and thermal properties of the obtained cellulose aerogel were investigated with the help of various spectroscopic techniques. Although there are many studies on the above-mentioned interactions in the literature, it seems that there are not many comparable studies on the production and detailed characterization of cellulose aerogel isolated from local wastes. It is thought that this study will shed light on various studies on the potential applications and production of biopolymers and new environmentally friendly industrial aerogels.

## 2. EXPERIMENTAL SECTION

### 2.1. Materials

All chemicals (urea, sodium hydroxide and ethanol) were of analytical grade and purchased from Merck. All the solutions were made with deionized (DI) water. The isolation of cellulose fibers from PBW was performed by way of an environmental friendly process for cellulose extraction and bleaching .

### 2.2. Cellulose production from PBW

Then, it was washed with DI water for a few times and filtrated using a cloth strainer to remove impurities such as water soluble sand, soil etc. Alkali treatment was carried out in NaOH solution of 4 wt% at 80°C for three times. Alkaline treated fibers were subjected to $NaClO_2$ or $H_2O_2$ bleaching of 1.7 wt% in acetic acid buffer at 80°C for 4 times. The resulting fibers were strained and rinsed with DI water and cloth strainer until it reached neutrality. Afterwards, the PBW sawdust powder was oven dried at 105°C.

### 2.2. Acid Treatment

Bleached PBW product was hydrolyzed in pre-heated $H_2SO_4$ (64 wt%) [20]. The high concentration of acid was removed through centrifugation at 10.000 rpm for 10 min and repeated until the solution was blurry. The resulting cellulose suspension was filtered using glass filter or cellulose membrane in DI water until the suspension reached a pH: 5.

### 2.3. Production of Cellulose Aerogels

Cellulose fibers (2 wt %) were dispersed into a sodium hydroxide/urea solution (1.9 wt %/10 wt %) by sonicating for 6 min. Then the solution was placed in a freezer for more than 24 h for gelation to take place. After the solution had been frozen, it was then thawed at room temperature, followed by immersion into ethanol (99 vol %) for coagulation (3 h). The specimen thickness was controlled around 1 cm with a diameter of 3.8 cm using a beaker as a mold. After coagulation, solvent exchange was carried out by immersing the gel in DI water for 2 days. Freeze-drying was carried out for the sample for 2 days at −98 °C with a freeze-dryer after prefreezing the sample at −18 °C for 12 h [21]. The chemical structure of cellulose is given in figure 2.

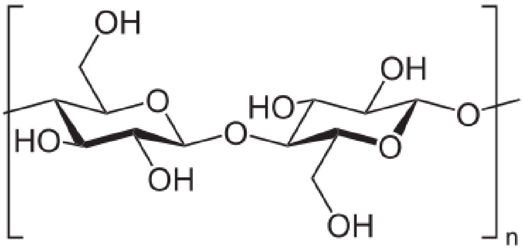


*Fig. 2. Cellulose Chemical Structure*

## 3. RESULTS AND DISCUSSIONS

### 3.1. SEM Analysis

Structural and morphological features of CA were visualized by SEM and shown in Figure 3. It is clear that cellulose aerogel has a largely homogeneous porous structure composed of microfibrillar networks (Fig. 3). The pore structure results from the sublimation of frozen water during the freeze-drying process [22]. This property is in line with the nitrogen adsorption data set in section 3.5 and seems to be justified by crystal formation during the relatively slow freezing process, which causes the fibrils to be pressed to form the film-like structure [23]. According to the above-mentioned findings, CA with a homogeneous microporous structure can be produced by in situ template synthesis of the sample in the cellulose gel framework [22].

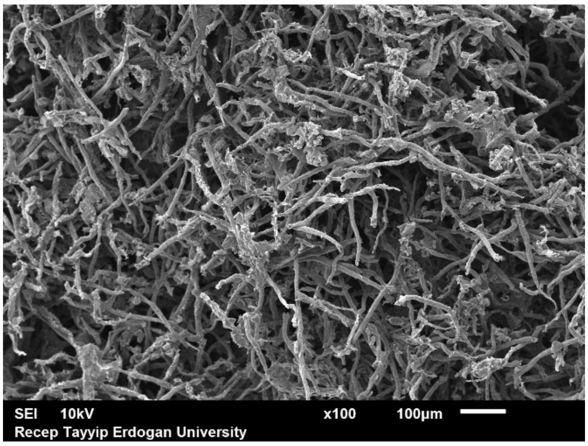


*Fig. 3. SEM image x100 of Cellulose Aerogel*

### 3.2. FT-IR Analysis

The IR signal of the characteristic functional groups is shown in Figure 4. It can be observed that various components of cellulose aerogel are most likely composed of alkenes, esters, aromatics, ketone and alcohol, and different oxygen-containing functional groups are observed. , for example, OH (3450–3300 cm-1), C=O (1775–11680 cm-1), C–O–C (1162 cm-1) and C–O–(H) (1050 cm-1 ).

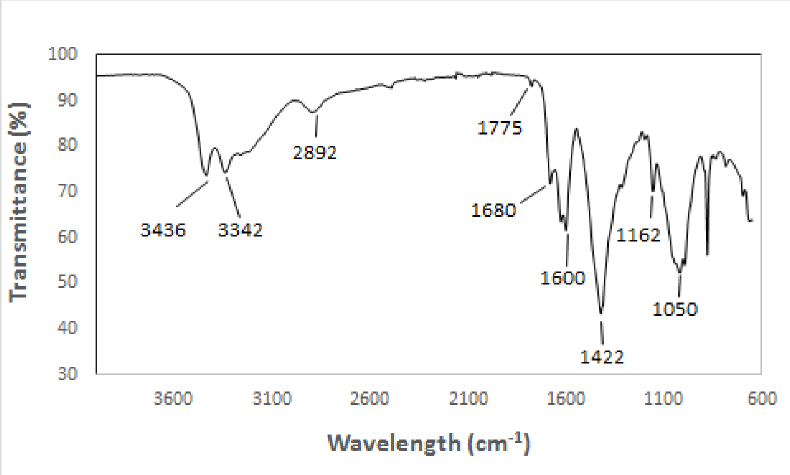


*Fig. 4 FTIR spectrum of cellulose aerogel*

### 3.3. Heat analysis

Considering the industrial applications of thermal insulation materials, the thermal behavior of CA was investigated by TGA analysis. A gradual weight loss occurs, up to about 500 degrees, as shown in Figure 5. Weight loss in the 0°C-200°C temperature range can be attributed to both surface moisture loss and internal moisture evaporation in the porous structure where water removal is relatively difficult. The weight loss step around 300−500 °C can be attributed to the depolymerization of cellulose with the production of CO2 and volatile hydrocarbons. Finally, CA turned out to have high thermal stability (weight loss only 60% at about 350°C).

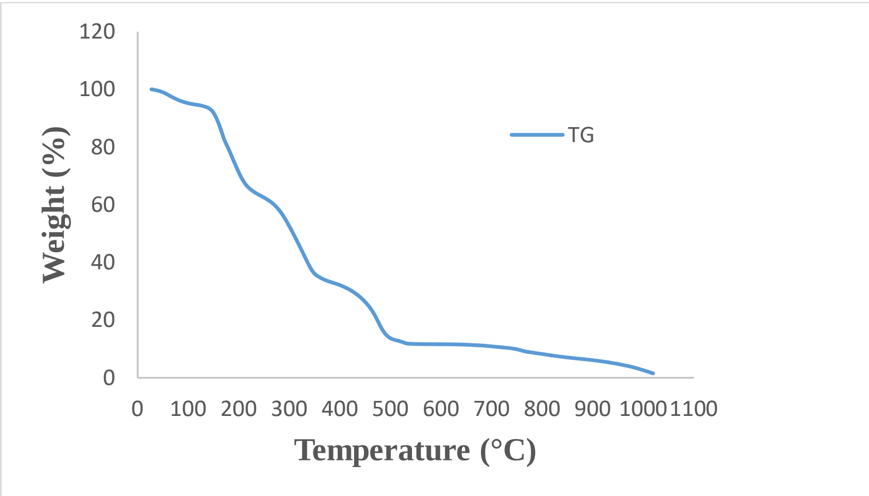


*Fig. 5 Mass loss of cellulose aerogel with temperature*

## 4. CONCLUSIONS

The highly porous cellulose aerogel was produced from pruned branches and blueberry bushes by converting the in-situ cellulose hydrogel scaffold into aerogel. This work is an efficient, environmentally friendly, low-cost process, and the biopolymer material is an effective flame retardant, porous, potential superabsorbent (later studies). It was concluded that the prepared cellulose aerogel has highly porous meshes and excellent flame retardant performance. In addition, cellulose aerogel has good crystallinity and thermal stability. This eco-friendly and low-cost study will provide insight into new opportunities for using inexpensive waste-derived cellulose to manufacture several materials. “Green” materials chemistry has great potential application in the future and could be suitable for industrial scale production.

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# Analysis of Temperature and Relative Humidity Variations in the Large-Caliber Ammunition Containers of NATO and Eastern Concept Depending on the Change of Seasons

***Berko Zecevic[1], Nurin Zecevic[2], Jasmin Terzic [3], Miroslav Sain[4]***

***Abstract***

*The design and materials used for large-caliber ammunition containers significantly effect on its shelf-life, safety and functional reliability during the handling and storage process. All ammunition containers should protect the ammunition in the required operating environment during extreme weather conditions, in terms of water resistance and protection from corrosion and fungi, and ammunition inside of the container needs to withstand all shocks caused during handling and transport. There are significant differences in the design, construction and materials used for the containers of NATO concept and ammunition containers of Eastern concept. The basic differences between these two concepts are reflected in the degree of protection of ammunition during extreme changes in temperature and relative humidity in ammunition storage and inside of containers. The NATO concept of ammunition container is consisted of outer and inner lining, where outer lining is usually made of wood or steel sheet. The inner lining protects the contents from the influence of environmental parameters (temperature, relative humidity). The Eastern concept of a large-caliber ammunition containers usually does not have an inner lining. The aim of the experimental research carried out in four different containers, was to identify and analyze the degree of variations in temperature and relative humidity in ammunition containers of NATO and Eastern concept during the storage, depending on the change of seasons. Using a Tinytag Plus TGIS-1580 data logger, the changes in temperature and relative humidity were measured, inside and outside of ammunition magazine, inside the ammo box and inside of fiber container. Experimental research showed large influence of the design of outer and inner lining of ammunition containers on the variation of environmental parameters. Since the ammunition is expensive and tends to have a longer shelflife, it is necessary to implement NATO concept of ammunition containers on ammunition packaging of the Eastern concept.*

**Keywords:** ammunition, shelf-life, storage, wood or metal box, fiber container, temperature, relative humidity

## 1. INTRODUCTION

At the end of twenty century, drastic changes were made in political and military relations between the great powers in the world, resulted in the number of a new conflicts, some of which continue with varying intensity.

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These conflicts are characterized by a mass use of large caliber ammunition, where ammunition is transported by all available means of transport (by road, sea, rail etc), stored in the open air or earth covered magazines, on different climatic and geographical locations. In such conditions, it is extremely important to know and respect all parameters that can affect the shelf-life of ammunition, and to ensure that ammunition and explosives (AE) are fully ready and safe for potential transport, handling and use of the same.

One of the main and most influential parameters that affect the safety of AE and its storage, are environmental parameters, because temperature and relative humidity of the air in ammunition magazine have significant impact on the condition and overall life of ammunition. Climatic changes, through large osciliations of daily temperatures and relative humidity, whose values deviate from the set of safety standards, directly affect on the process of ammunition performance degradation, performance of propellants in propellant charges, explosives in warheads and pyrotechnic components and igniter systems.

The issue of ammunition maintenance is a very important and every effort should be made to ensure safe conditions prevail in storage and transportation, because factors as higher temperature, rain, dampness and humidity can cause enormous damage to AE in a very short time [1]. If the manfacturers' environmental conditions are not met, the performance of explosives will be unpredictable and the safety will be reduced [2]. From financial side, aspect of ammunition storage is significant, since about 50 % of the total costs for the process through which the ammunition goes (design, production, storage and demilitarization), is necessary for AE storage. But more often the importance of adequate storage is being neglected. Unfavorable condition for AE storage, with significant temperature fluctuations and high relative humidity for a longer period of time, can also cause a drastic shortening of ammo life and the need to use it as quickly as possible. The service life of such ammunition in the new real storage conditions is no longer as prescribed by the manufacturer. The issue of maintaining such ammunition has become essential. The need for periodic inspection and inspection of ammunition has become one of the vital activities of modern Armies focused not only on safety, reliability and performance functionality, but also on issues of operational status of ammunition in low-intensity wars.

### *1.1. The effects of air temperature and relative humidity on ammunition*

Ambient air temperature does not necessarily mean the temperature of ammunition, temperature of explosive substances in warheads, rocket motors or propulusion charges in chartridge. This is particularly the case when the ammunition is stored and used in dessert areas, where solar radiation significantly increases local temperature on some parts of ammunition [3]. Storage of AE on air temperature of 60 or 70 ˚C in dessert has totally different effect than storage in the magazine at 15 ˚C temperature in Central Europe [4]. Experience from the use of ammunition in the combat conditions showed that if ammunition prepared for combat use, stay outdoors for a longer time, under the strong influence of solar radiation, it can in some cases reach temperature on lancer up to 100 ˚C or ammunition inside of tanks and armoured fighting vehicles without air conditioning can reach 90 ˚C [3].

Recommended temperature in the storage should be in the range 5 do 25 ˚C. In the situation of storing AE for a longer period, it is necessary to take into account the temperature values are not the same during summer and winter period, and there are differences in daily values. Temperature values, lower and higher than standard, can have a very negative effect on the structure and performance of AE in the storage. Very low temperature are not as objectionable as higher ones, but explosive that contain nitroglycerin can become dangerous at very low temperature or it can change physical properties of material of which explosive is composed. Higher air temperature can intensify degradation reaction of certain components inside of explosive matters and reduce ballistic performance or cause chemical degradation of material and appearance of gases causing cracks of propellant [5]. Increasing the temperature for about 10 ˚C above the recommended temperature of 25 ˚C, can generally speed up chemical reactions by 2 to 3 [6].

Impact of the humidity can be very complex and significantly depends on the air temperature. Higher relative humidity can cause ammunition damage and lower humidity causes static electricity for some type of stocks. The penetration of moisture through the hermetic systems in complex projectiles can cause failures of the functions of vital components, causing chemical reactions in ignition systems based on aluminum and magnesium. In ammunition packaging systems or in the case of poor packaging, the free moisture released during the daily temperature cycle can cause long-term corrosion of the metal components of the ammunition and thus reduce the functional capability of the ammunition in combat use. The physical effects of the influence of temperature changes during diurnal temperature cycling and high temperatures in the warehouse can cause the appearance of high stress states and the appearance of cracks in the zones of contact of explosive matter with the ammunition structure [5].

Contemporary research of the impact of environmental parameters on the condition of ammunition have shown that it is no longer enough to read the temperature once a day, but it is necessary to continuously monitor the temperature and humidity inside the ammunition packages. In this way, the precise data, necessary for estimating the remaining life of ammunition, are obtained [5]. There are significant deviations in the measurement of real air temperature during the daily cycle in relation to the state of measurement of long-term mean temperature over time for a given storage location. In addition, a very important factor is the monitoring of temperature and humidity within the ammunition packages themselves, as this provides more accurate data necessary to estimate the remaining life of the ammunition.

Since ammunition may deteriorate or become damaged unless it is correctly stored, handled and transported, with the result that it may fail to function as designed and become dangerous for storage, transport and use [5, 7], therefore it is important to know environmental conditions where the ammunition is stored, considering important parameters as actual atmospheric parametes outside the magazine over a longer period of time, parameters inside the magazine, efficiency of natural ventilation in the magazine and variation of temperature and relative humidity inside the package of ammunition. The design and used materials of the packages can significantly influence on the ability to reduce the impact of external influences of environmental factors.

### *1.2. The importance of ammunition package*

Ammunition package is a crucial factor in maintaining the integrity of ammunition. It represents a key safety measure in the process of handling, storing and transporting ammunition until the moment of the use on the battlefield. The design and materials of the ammunition container significantly affects on its service life, safety and functional realiability during the handling and storage process [2]. NATO and Eastern (China, Russia) ammunition container concept is the mostly used in the world. But there are significant differences in design approach, construction and used materials between these two concepts.

The basic differences between these two concepts are reflected in the degree of protection in extreme changes of temperature and relative humidity in magazines (during the change of seasons) and the ability to absorb shocks during handling and transport. The NATO concept of a large-caliber ammunition container implies that the container contains an outer coating that protects the contents during the transport, handling and storage process. The outer cladding is usually made of wooden materials or sheet steel, and more recently of reinforced plastic. Internal linings protect the contents from the effects of the environment (temperature, relative humidity) and have additives that prevent displacement and absorb the effects of shock and vibration. The inner linings are in the form of fiber containers or made of composite plastic materials. The Eastern concept of a large-caliber ammunition containers usually did not have an inner lining, larger ammunition was placed in wooden crates with very primitive accessories to prevent the movement of ammunition. There were packaging designs where the ammunition was loaded into special metal containers and then together with the projectiles into wooden crates (125 mm tank ammunition). In a recent years, the situation has changed and the packaging of the Eastern concept ammunition has been improved. Theoretically, all ammunition containers should protect the ammunition in an extreme weather conditions in demanding operational environments, it should be waterproof and resistant to corrosion and fungi, and allow the ammunition inside the container to withstand all shocks caused by handling and transport.

## 2. AIM AND METHOD OF RESEARCH

The aim of the experimental research which was performed in four different ammo containers, is to identify and analyse the degree of variations in temperature and relative humidity values, measured in NATO and Eastern concept ammunition containers during changes of seasons [7].

Ammo containers were located in the Earth Covered Magazine (ECM), located on geographical area surrounded by forest and mountains, and it was not under direct influence of the Sun. Due to it, it was characterized with periodical intense changes in temperature and relative humidity. Containers were located next to the wall of magazine, 5 m from the entrance door. Magazine does not have HVAC system for a indoor climate control and the ventilation is natural. It has two front openings for air entry and one air outlet. Within the ammunition magazine, four types of ammunition packaging were placed, which differ in the design of the outer and inner packaging and the used materials for the packaging structure. Measurements performed during all four seasons made it possible to monitor changes in temperature and relative humidity in the storage area of ECM, inside the outer packaging and inside the inner containers.

Measurement of temperature and relative humidity was performed with Tinytag Plus Intrinsically Safe Dual Channel Temperature / Relative Humidity (-40 to + 85 ° C / 0 to 100% RH) by Gemini Data Loggers (UK) Ltd, which provide continuous monitoring of temperature and relative humidity within hazardous storage areas and during transport of hazardous substances. Data loggers are powered by batteries and can continuously measure changes in atmospheric parameters 24 hours a day, seven days a week, 12 months a year. Data logger TGP-4500 Tinytag with dual channel for measuring temperature and humidity (-25 to + 85 ° C / 0 to 100% RH) has a high resolution and accuracy of data reading, waterproof (IP 68) and designed for outdoor use and industrial applications. The TGP-4500 sensor was placed in the entrance area of the ECM. Data logger TGIS-1580 Tynitag with special safety with double channel for measuring temperature and humidity (-40 to + 85 ° C / 0 to 100% RH) is an ATEX certified data logger for use in hazardous areas, as which are ammunition depots. TGIS-1580 data loggers were placed inside ammunition magazines, inside crates, fibers and metal cylindrical containers to measure changes in temperature and humidity. Measurements of air parameters with data loggers were performed every 20 min. The obtained results of daily maximum and minimum parameteres values, differences between dailymaximum and minimum air parameters and mean parameter values for each measurement day were identified and processed. Parameters of temperature and relative humidity in ECM represent the basis for comparison with the data inside the ammunition packaging.

## 3. RESULTS OF EXPERIMENTAL RESEARCH

Throughout the research period, the parameters of the air in front of and inside the magazine were measured. Measurement results were processed in the way that the average daily values of temperature and relative humidity were determined for a clearer comparative analysis.

Over a period of one year of research, the difference between the maximum and minimum values of daily temperature changes in in front of the ammunition magazine ranged from a few degrees Celsius to 27 ˚C. In the winter, the lowest temperatures were down to -19 ˚C and the highest in summer up to 34 ˚C (Figure 1, left). During research period, the relative humidity was high most of the time, often up to 100 % (Figure 1, right).

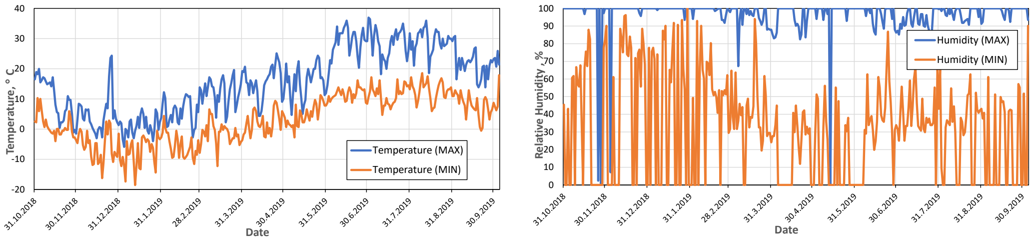


*Figure 1. Temperature (left) and relative humidity (right) on site of ECM*

Characteristics of the magazine, as earth covered concrete structure, and the existing concept of natural ventilation system, had influence on measurement results. Average temperature in the magazine for considered measurement period, in the winter ranged up to 5 °C, while in summer period it reached maximum 18°C. The deviations of daily maximum and minimum temperatures in the magazine did not exceed a few Celsius degrees (Figure 2, left). Average daily relative humidity for a measurement period was in the range 55-95 %, while in some parts of the day, relative humidity value reached up to 100 % (Figure 2, right).

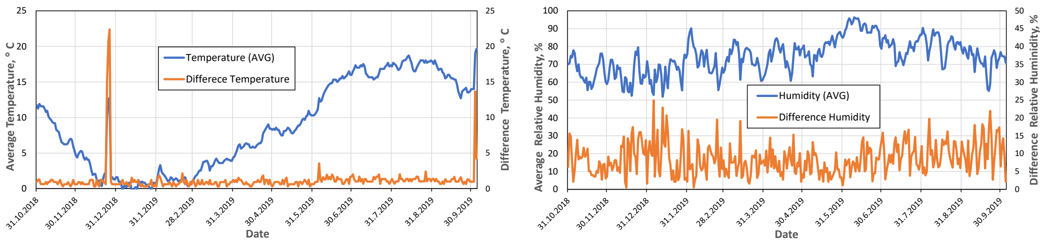


*Figure 2. Average Temperature (left) and relative humidity (right) in ECM*

First measurement packing, cartridge propelling 105 mm L35, was consisted of metal box, where inside were placed two cylindrical plastic containers (Figure 3). Plastic container was consisted of brass cartridge case, electric igniter and five incremental charges (Figure 3, right).

*Figure 3. Cartridge propelling 105 mm L35, packing*

Measurement results of air parameters inside of metal box and plastic container for Cartridge propelling 105 mm L35 are shown on the Figure 4. Character of temperature changes in a metal box and in plastic container is similar to temperature changes inside of ECM. Variations of daily temperature values inside of both packages were up to do 4°C, in comparance to the temperature in ECM.

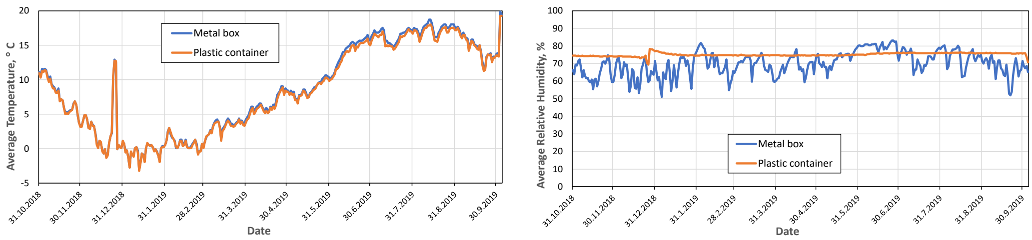


*Figure 4. Temperature (left) and relative humidity (right) in Cartridge Propelling Packing 105 mm L35*

Relative humidity inside of the metal box was lower by 15 % in comparance with relative humidity inside of ECM. Character of relative humidity variations inside the metal box during measurement period was similar to variation of relative humidity inside of magazine because metal box of this package has several openings on its structure and there was air circulation through openings.

In the case of a plastic container, there is a sealing system that prevents air penetration from the metal box to the inside of plastic container and there were no significant changes in the relative humidity in comparance to the parameters, at the time of closing the container. The variations of relative humidity was up to 3% (Figure 4, right). More precisely, the relative humidity at the time of closing the plastic container remained "frozen" in comparance to the initial state.

Second measurement packing for mortar ammunition HE 120 mm M62, was consisted of wooden box, were two fiber containers with ammunition were placed (Figure 5). Fiber container is made of craft paper and from the outside it was impregnated with a layer of asphalt varnish in order to protect it from moisture penetration.

*Figure 5. Mortar ammunition 120 mm M62, packing*

Temperature and relative humidity variations of Mortar ammunition 120 mm, M62 are shown on the Figure 6.

Intensity of temperature changes inside of wooden box and fiber container was similar to the character of temperature changes in the ECM during measurement period. Daily variations of relative humidiy in the wooden box in comparance with relative humidity in the magazine had lower intensity by about 10 %, with a certain delay in reaction due to the process of heat transfer through the structure of package.

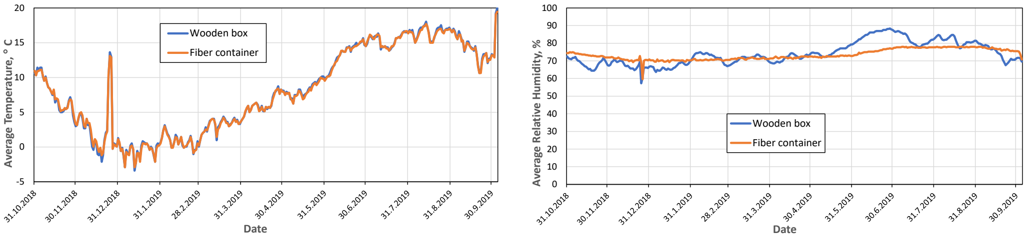


*Figure 6. Average Temperature (left) and relative humidity (right) in Packing for Mortar ammunition 120 mm HE M62*

Relative humidity changes in fiber container had minor variations over the time in relation to changes in wooden box, due to the outside waterproof layer of asphalt varnish on the fiber container surface (Figure 6, right). Initial parameters of relative humidity in the moment of installation of ammunition in the fiber container, and after closing the lid with a hermetic coating, retained same in the container. Resulting small variations of relative humidity inside of fiber container are the result of temperature changes and ability of material inside of fiber container to absorb and release moisture.

Third measurement packing for tank ammunition 125 mm, APFSDS-T, M88 was consisted of wooden box, in which were two metal containers placed (Figure 7). One container contained a projectile 125 mm APFSDS-T M88 with additional propelling charge, and in second container, main propelling charge was placed.

*Figure 7. Tank ammunition 125 mm APFSDS-T M88, packing*

Variations of temperature and relative humidity inside of ammunition 125 mm APFSDS-T M88 are shown on the Figure 8. Intensity of temperature changes inside of wooden box and metal container during daily cycles was similar to temperature changes in the ECM. There are significant differences in the character of daily variations of relative humidity inside of wooden box, in comparance to relative humidity variations inside of ECM, characterized with more intensive variations. Relative humidity averagely ranged between 70% and 80%.

Measurement results of relative humidity in the metal container had slightly variations during entire research period in comparance to the changes in wooden box. Variations of relative humidity were for about 25 % lower compared to the relative humidity of wooden box. Metal container practically "freezes" the state of air from the aspect of relative humidity in the moment of installation of ammunition and closing the container.

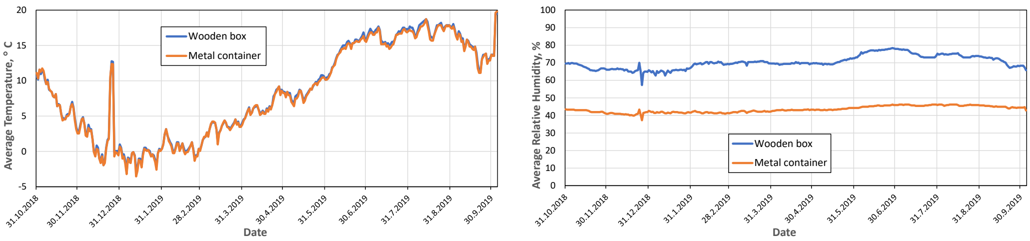

*Figure 8. Average Temperature (left) and relative humidity (right) in packing for ammunition 125 mm APSDFS-T M88*

Fourth measurement container for propelling charge, intended for HE ammunition 155 mm. It was consisted of cylindrical metal body and a lid with a sealing system (Figure 9.).

*Figure 9. Propellang charge for ammunition 155mm, Metal container*

Variations of temperature and relative humidity inside of packing for propelling charge for ammunition 155mm are shown on Figure 10.

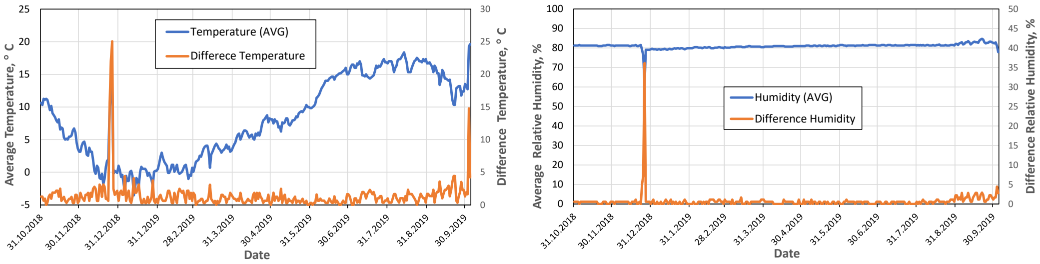


*Figure 10. Average Temperature (left) and relative humidity (right) in Metal Container for Propellant charge of 155 mm Ammunition*

Character of the temperature changes in a metal container was similar to the changes inside of a magazine, as it was previously described for three ammo packages cases. Relative humidity in a metal container also had slightly variations as it was a case for the metal container of a third package for a tank ammunition 125 mm, APFSDS-T, M88.

By comparing the measurement results of air parameters changes for all four ammo packages, several important facts can be observed. The character of temperature changes inside all three ammo packages and metal container for propellant charge of 155 mm ammunition, during daily cycles was similar to the changes of temperature inside of magazine, during entire research period. Temperature inside of packages was for a few degrees of Celsius lower than the temperature inside ECM (Figure 11).

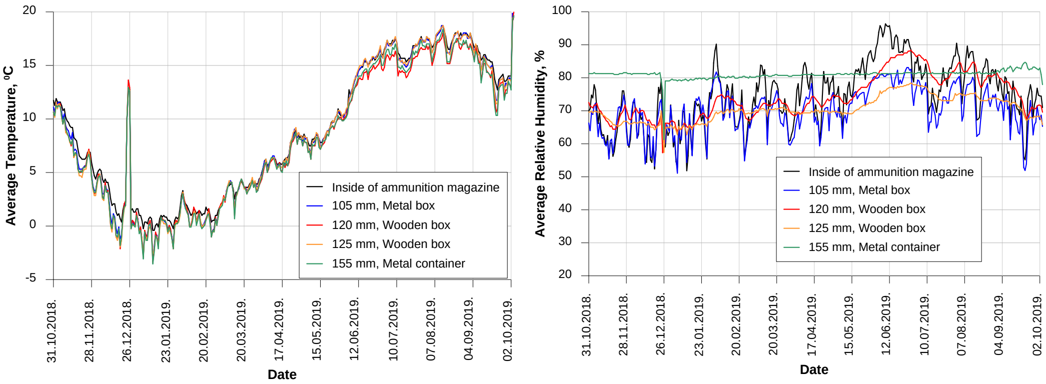

*Figure 11. Comparative temperature and relative humidity air measurement data for external packaging of ammunition*

With metal propelling container for ammunition 155, changes of relative humidity is insignificant, because there are system for hermetizing the container, where the current condition of the air from the aspect of relative humidity is maintained until the next opening of the container (Figure 11, right).

Changes of relative humidity inside of plastic, fiber and metal container were less intensive in comparance with the case of ECM (Figure 12). Slightly greater variations are observed in fiber container 120 mm M62, whose inner layer is made of craft paper which is not watertighted, and then in metal container for ammunition 125 mm APFSDS-T, which also has inner layer made of craft paper, but with a better sealing system for a metal container.

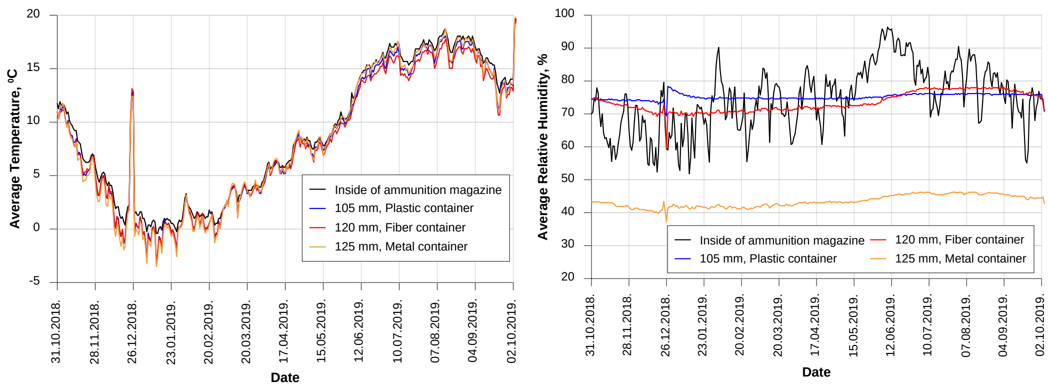


*Figure 12. Comparative temperature and relative humidity air measurement data for internal packaging of ammunition*

## 4. CONCLUSION

Based on results of measurement period of one year, it can be concluded that variations of temperature inside of outer and inner lining of ammunition package follows variation of temperature inside of ECM.

Changes in relative humidity inside of outer packages that were not hermetic follows the relative humidity changes within ECM, with a certain delays in reactions. Variatons of relative humidity changes were slower and with lower intensity. This is especially pronounced with the outer wooden package, while in the case of metal container with openings on its structure, variations of changes are more intense due to the direct contact with the air in a storage.

Changes of relative humidity at inner packages are unsensitive on changes of relative humidity inside ECM, but strongly depends on initial values of air parameters, temperature and relative humidity, at the moment of closing container, amount of matter inside of container that have ability to absorb moisture and method used for container sealing.

ECMs as one of the mainly used types of magazines, very often in some cases can have moisture-intrusion problem due to its characteristic covered layers and poorly performed hydroisolation. If ventilation system is not adequate, higher values of air parameters can seriously affect safety of magazine and ammunition inside of it.

Maintenance of ammunition is crucial and every effort should be made to ensure safe conditions for storage, transport, handling and use of ammunition. Some of the most significant and influential factors to achieve that are well performed and maintained ECM with efficient ventilation system to provide adequate ventilation, well designed ammunition package, periodical inspection and continuous monitoring and maintenance of temperature and relative humidity at reasonable level.

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# Renewable resources versus fossil energy and new green economic world in the EU

***Erhan Atay[1]***

***Abstract***

*Global energy sector has become cleaner in recent years, but deeper reforms still are needed.It is suggests that continued efforts to decarbonize the grid will depend on significant investments in research and development, along with more governmental guidance over transmission planning to enter green economy.The shallow decarbonization of the energy sector has led to a switch from coal to renewables for power generation, and has led to some successes with energy efficiency that have helped hold down growth in energy demand. But,these factors help reduce emissions of conventional pollutants. Those were probably the easy part. Looking ahead to meeting our climate goals, which constitute avoiding to the greatest extent possible the worst effects of climate change, we need deep decarbonization. Therefore,as the a radical solution the global warming ,the Paris Climate Agreement, made as part of the United Nations Framework Convention on Climate Change, set a common goal among all signatories: reduce carbon emissions enough to keep the global temperature from increasing more than two degrees Celsius from where it was during the pre-industrial era. In this regard, Paris Climate accord is extremly important.*

**Keywords**: : Renewable energy, green jobs, The EU, Paris Climate Accord

## 1.INTRODUCTION

Today, we too must understand that fossil fuels on Earth are not renewable and how valuable they are.

On the other hand, I think the real dilemma here lies in fossil fuels, they are running out and more attractive and less polluting competitors such as renewable energies are coming to the stage.

In this regard,when making a green job definition, it should be foreseen that this definition differs in terms of developed and developing countries. While environmentally sensitive jobs are expressed with highly advanced technologies in a developed country, from the perspective of developing countries, they can be described as less environmentally sensitive jobs due to the low technologies they have.

Intense change is emerging in current occupations, while a few relevant new pastimes occur in the transition to green jobs.

Moreover, the change in the level of all qualifications in the skills profile and in all sectors requires education and training related to the needs of the labor markets.

It is expected that carbon-intensive industries will experience unemployment despite the positive impact of the green economy on employment. For successful transitions from old to new, green industries and occupations require effective retraining and skills upgrading.

The key to transformation is the development of targeted education initiatives by dividing the population to address the typical disadvantage of the labor market. Skills development is a critical point in unlocking

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employment potential green growth, as skills and environmental policies often need to be addressed from one to another.

For example, the new regionalization, which came to the agenda on 15 November 2020 and expressed as RCEP in the ASEAN region, which constitutes 30% of the world's GNP and 2.2 billion of the population, is the largest FTA in human history. Even for the purposes of polarization formation, there is hardly any reference to labor force and environmental sensitivity.

Therefore,a number of recent studies on the determinants of economic growth highlight the importance of total factor productivity, such as Easterly and Levine (2000), who explain that the salient features of countries growth experience cannot be explained by factor accumulation alone.

The outline of the study is as follows.Section 2 discuss after the introduction EU's renewable energy with Paris Climate Accord.Section 3 deals with green jobs and skills and last section is conclusion.

## 2.The EU's RENEWABLE ENERGY CHESS with PARİS CLIMATE ACCORD

Both economic theory and experience of some countries that have attempted to build a green-energy economy that will create green jobs and skills in the EU.

We can define the green economy as 'an economy that reduces environmental risks and ecological scarcity and aims at sustainable development without destroying the environment'.

The idea of limiting the use of fossil fuels (coal, oil, natural gas) and turning to renewable energy (wind, water, geothermal, biomass and solar energy) sources lies behind the green economy idea that suggests the use of low carbon.

In this regard,in 2020, 53 cities in 10 countries introduced or implemented regulations that prohibit or restrict the use of natural gas, oil or coal in the heating and cooling of buildings. 163 cities have ended the use of fossil fuels. One thousand 852 cities announced a climate emergency action plan. This figure was 1,400 in 2019.

### *2.1.Renewable energy's future in the EU*

Renewable energy will play a very critical role in our near energy future, but we should not expect everything from renewable energy, especially as the mistake some environmentalists made. As Claude Mandil emphasized, renewable energy will contribute to energy diversity and supply security and economic growth. According to the estimation of the (IEA) international energy agency, the share of renewable energy in electricity generation will reach 20% in the 2030s. [1].

In practice, especially in discussions in Europe, but also in China or the USA, we have started to hear more and more often that large investments are needed to discover non-polluting technologies and renewable energy sources that are enough for the world to get rid of hydrocarbons completely. Ecological breakthrough policy discussions are very popular, especially in Europe, as many people in Europe see such a move as a way out of today's economic recession. [2].

In line with the EU's 2020 commitment to reduce all greenhouse gas emissions by 20% compared to the 1990 level, a target of 130 gr $CO_2$ / km has been set in automobiles with vehicle technologies, and 120 gr $CO_2$ / km using other methods. This target is determined as 95 gr $CO_2$/ km for the year 2020. Our country, which also continues its EU membership studies, aims to achieve the low carbon emission standards set by the EU countries, which are the largest purchasers of its products, especially automotive and sub-industry [3].

On the other hand,the past five hundred years have witnessed an unprecedented ascendancy of human domination. In 1500, there were about 500 million homo sapiens in the world. Today, this number is exactly 7 billion. In 1500, the total value of goods and services produced by humans was 250 billion dollars. Today, the annual production is approximately 60 trillion dollars.

Recently there has been increasing interest in the environmental impacts of international trade, especially in emissions embodied in trade. Instigated by globally increasing attention on climate change, energy and carbon dioxide ($CO_2$) emissions embodied in trade has been investigated in particular, primarily at national, but also bilateral and global levels. [4].

While people consumed 13 trillion calories of energy per day in 1500, today's energy consumption was 1500 trillion calories per day. If you pay attention, human population has increased by 14 times, production has increased 240 times and energy consumption has increased by 115 times. [5].

An unrelenting increase in fossil fuel extraction conflicts with the finite nature of these resources. At the same time, the global distribution of oil and gas resources does not match the distribution of demand. Therefore, some countries currently rely almost entirely on imported fossil fuels. Therefore, is the relative scarcity of fossil fuels an additional reason an energy transition? [6].

In taking account of the interrelationship between energy and other primary resources, labour and capital, Mountain (1985) presents a methodology for quantifying regional efficiency differentials using Taylor series approximations to profit functions representing regional economies. The resulting formulation makes it possible to decompose labour productivity into its contributing factors which now include energy price differentials in addition to such traditional variables like differentials involving capital employee ratios and the quality of labour [4].

Oil production almost doubled between 1965 and 1975. After the early 1990s, it grew almost constantly and by 2017, the production volume was about three times higher than in 1965 and twice as high as in 1985. Unlike coal, there is no sign of a decline in oil production in response to reduced demand. Oil production is more widely distributed than coal production. Three countries, the USA, Russia,and Saudi Arabia, have global market shares of around 12–14% each, whereas four countries, Canada, Iran, Iraq, and China, produce around 5% each. The other oil-producing countries have significantly lower market shares. [6].

Initially, trade unionists understood ‘just transition’ to be a program of support for workers who lost their jobs due to environmental protection policies. Since then,several UNFCCC Climate Conferences have referred to the ‘just transition’ concept.

In summary, the global fossil fuel extraction industry must reduce production at a rate of 2% per annum under the 2.0 °C Scenario and 3% per annum under the 1.5 °C Scenario. A constant reduction in production seems unlikely if no international measures are taken to organize the economic and social transitions in the producing countries, and for the communities and workers involved. The idea of a ‘just transition’is well documented in the international literature. According to the International Labour Organization (ILO 2015), the concept was first mentioned in the 1990s,when North American unions began developing the concept of just transition.

### *2.2.Paris Climate Accord and US versus EU*

The Paris Agreement would not have come into being had China, the United States (US), and the European Union (EU), which together contribute more than half of all global greenhouse gas emissions, not signaled their intent to take major steps to reduce their domestic emissions. The EU has been at the forefront of global climate change measures for years having issued binding domestic emission reduction targets for 2020 and 2030. Given that the commitments made in Paris are most likely insufficient to keep global temperature from rising 2 °C above pre-industrial levels, the commentary also considers what the likelihood is that these three major economies will strengthen their emission reduction targets in the near future [7].

The Paris Agreement is extremely vulnerable to the withdrawal of the US, or any other major party. It possesses no non-party measures, although it can be amended to help avoid this Achilles heel. Through amendments to Article 6 a market link between subnational states in a renegade US and international carbon markets could be created. Ideally, a more semi-global approach with punitive carbon border tax adjustments could be taken to help US-proof an alternative climate agreement. The Paris Agreement will be fatally susceptible to a US dropout unless amendments to the treaty are made. Relying on the good will of a single president is short-sighted. Longer-term climate governance needs to take seriously the threat of non-parties, particularly if they are superpowers [8].

The Paris Climate Agreement 2015, during the 21st session of the Conference of the Parties (COP 21) “decided to continue and improve the forum on the impact of the implementation of response measures (hereinafter referred to as the improved forum), and adopted the work programme, comprising two areas: (1) economic diversification and transformation; and (2) just transition of the workforce, and the creation of decent work and quality jobs” [9].

## 3.GREEN JOBS and SKILLS in the EU

If we take into account green economics;it points to those who direct their own energy future with their own hands, in addition to emission reduction, many benefits at the local level: creation of local employment, increased welfare and quality of life, and healthier city residents are among these benefits.

Therefore,Kuznets (1955) argued that there is an inverse-U-shaped relationship between economic growth and income inequality. Thus, increasing income inequality in the first phase of economic development will decrease with continued economic development. there is an inverse-U-shaped relationship between growth .Another idea underlying this hypothesis is that environmental goods are normal goods, according to which high income increases will increase the demand for a cleaner environment, these political phases will cause structural changes, resulting in more environmentally friendly production processes and more efficient use of resources [10].

### *3.1.According to the Paris agreement;Employment*

The transition to a 100% renewable energy system is not just a technical task, it is also a socially and economically challenging process. It is imperative that this transition is managed in a fair and equitable way. One of the key concerns is the employment of workers in the affected industries.

In 2015, the Institute for Sustainable Futures (ISF) at the University of Technology Sydney (UTS) developed a quantitative employment model that calculates employment development in the electricity, heating, and fuel production sectors for the analysis of future energy pathways [11].

Renewable energy’s share of the total final energy consumption has increased only modestly in recent years, despite tremendous growth in the modern renewable energy sector. There are two main reasons for this. One is that the growth in the overall energy demand (except for the drop in 2009 after the global economic recession) has counteracted the strong forward momentum of modern renewable energy technologies. The other is the declining share of traditional biomass, as people switch to other forms of energy. Traditional biomass makes up nearly half of all renewable energy used, and its use has increased at a rate lower than the growth in total energy consumption. [6].

Employment—Quantitative Results The 2.0 °C and 1.5 °C Scenarios will generate more energy-sector jobs in the world as a whole at every stage of the projection. The 1.5 °C Scenario will increase renewable energy capacities faster than the 2.0 °C.

Accordingly,scenario, and, therefore, employment will increase faster. By 2050, both scenarios will create around 47 million jobs, so employment will be within similar ranges.In 2025, there will be 30.9 million energy-sector jobs under the 5.0 °C Scenario,45.5 million under the 2.0 °C Scenario and 52.3 million under the 1.5 °C.

At the same time,employment and ‘’Employment—Occupational Calculations Jobs ‘’will increase across all occupations between 2015 and 2025, except in metal trades, which display a minor decline of 2%, . However, these results are not uniform across regions. For example, China and India will both experience a reduction in the number of jobs for managers and clerical and administrative workers between 2015 and 2025 [6].

### *3.2 Finance side of the fossil energy versus renewables*

Evaluating the banking sector's response to the "climate chaos", the 2021 Banking on Climate Chaos report, published by Rainforest Action Network, BankTrack and other non-governmental organizations, has shown that the world's 60 largest private banks have reached 3.8 billion dollar finance of fossil fuels since the Paris Agreement, which was signed in 2015. It had demonstrated that it provided trillion dollars of funding. This financing means 10 percent growth in fossil fuel projects planned in 2020.Although the problem of transparency regarding financing flows of development banks remains valid, it was seen for the first time in 2020 that multilateral development banks did not transfer project finance to coal. The analysis shows that the total project financing transferred to fossil fuels between 2018 and 2020 decreased by 40 percent compared to 2015-2017.

Natural gas accounts for 75 percent of the support provided by development banks to fossil fuels in 2020, as in the previous two years. This figure points out that financial support to natural gas is a priority area that all banks should address.The European Investment Bank stands out among nine multilateral development banks in financing for clean energy. The six billion dollars financing provided by the European Investment Bank for clean energy is equivalent to nearly nine times its financing for fossil fuels. The World Bank Group provides the bulk of fossil fuel financing. The World Bank has transferred 5.7 billion dollars to fossil fuels in the 2018-2020 period.

## 4.CONCLUSION

One of the Paris Agreement’s most outstanding achievements has been the consensus by 195 countries to limit climate change to well below 2 °C and to pursue their best efforts to limit it to 1.5 °C. Unfortunately it did not work until now due to the big powers unwillingness to the participate the necassary conditions. On the other hand,inequality in labor incomes between 1900-1910 and 1950-1960, contrary to the optimistic predictions in Kuznets' theory that the workforce would gradually and mechanically move from low-income activities to higher-income sectors, neither in the United States nor in France. and the rapid decline in total income inequality was mainly due to the collapse of higher capital revenues. All the data we have show that the same situation is valid for all developed countries. All data on the composition of income, especially at the total income level, support this. (See. [6].

Consequently,in meeting future green skill needs, ministries and employers and trainers should coordinate and countries should implement well-defined policy strategies, together with social dialogue.

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# Unintended Consequences of Climate Policies: ‘’Green Paradox’’ and An Environmentalist urope’s Green Deal Solution

***Erhan Atay*[1]**

***Abstract***

*Both economic theory and experience of EU countries that have attempted to build a green-energy economy that will create green jobs .Therefore, green paradox argues that some designs of climate policy,intended to mitigate carbon emissions,might actually increase carbon emissions,at least in the short run.The reason for this possibility is that fossil fuels are non-renewable scarce resources .*

*On the other hand, climate change and environmental degradation are an existential threat to Europe and the world. To overcome these challenges, Europe needs a new growth strategy that will transform the Union into a modern, resource-efficient and competitive economy, where The EU aims to be climate neutral in 2050.*

*In this context,the EU will also provide financial support and technical assistance to help those that are most affected by the move towards the green economy.It could be said that the EU’s efforts alone are not enough to tackle environment problems like climate change. Finally,in order to solve both green paradox and global warming EU’s 27 member states and its institutions must take steps as is explained in Europe’s Green Deal clearly.*

**Keywords**: The EU,Green Paradox, Europe Green Deal ,Climate Change

## 1. INTRODUCTION

Today, the world has fallen into a green revolution. Clearly, we can see this from the "European Green Consensus", which the EU has put on the agenda, and the subsequent US administration's "Renewable Energy" blinking as a result of giving some signals to return to the Paris Climate Change Charter in 2021.

Accordingly,in 2020, in worldwide 260 cities set renewable energy targets or implemented a new renewable energy policy. By the end of 2020, 834 cities in 72 countries have implemented their renewable energy targets. 357 of these cities are in Europe; 350 of them are in North America; 51 of them are in Asia. Today, over 600 cities around the world have a goal of 100 percent renewable energy.

In this regard,more than 10,500 cities have implemented targets to reduce greenhouse gas emissions. 800 cities made net zero emissions commitments. This ratio is 8 times the commitments made in 2019.

By the end of 2020, 800 local governments implemented regulations, tax and financial incentives that support the use of renewable energy in transportation and new buildings. 67 cities set a goal of 100 percent electric vehicle use.

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On the other hand,the EU is preparing to take the first action of the green consensus. Meeting during the week, the European Parliament (EP) made the first legal arrangement regarding the $CO_2$ tax on imports from third countries. In the regulation, it is emphasized that products produced in third countries that have not implemented this agreement because EU member countries are a party to the Paris agreement known as "Cop21" will cause unfair competition.

The products produced in countries that are not a party to the Green Deal agreement and do not pay attention to $CO_2$ emissions are expected to be subject to tax due to unfair competition and to be subject to environmental tax due to $CO_2$ trace. Legal arrangements are expected to be completed by 2023.

The paper is organised as follows after the introduction section 2 deals withUnsustainableClimate Policies and Green Paradox while section 3 discuss the EU's New Green Deal Plan and last section is conclusion.

## 2.TODAYS DILEMMA UNSUSTAINABLE CLIMATE POLICIES and GREEN PARADOX

Ecological degradation is not the same as resource scarcity: the resources available to humanityare increasing and will likely continue; current predictions of resource scarcity are probably not true; fear of ecological degradation has solid grounds.

In the future, we may witness the Sapiens possessing brand new sources of matter and energy, but the extinction of the remaining natural habitat and many other species [1].

### *2.1.Unsustainable Climate Policies*

Thus, climate policies that were designed to discourage fossil fuel use actually accelerate climate change, increasing the net present value of damages. In our simple model, the only way that a carbon tax would actually reduce total fossil fuel use and hence total emissions would be if the tax were so high that it completely choked demand and reduced the resource rent to zero [2].
Two of the key dimensions influencing the social and economic impacts of the transition from fossil-fuel to clean energy are the quantity and type of jobs that are lost and created.Currently, there are limited data on the volumes of jobs that will be lost and created within particular occupations and locations during the transition to clean energy.

National statistical agencies classify and collect data on occupations within the fossil fuel sectors but not within the renewable energy sectors .ISF has developed a model to estimate the volume of renewable energy jobs under different 100% global renewable energy scenarios and an increasing body of research is estimating the jobs created by renewable energy. [3].

How far can the oil reserves of the current world meet the needs of the global economy? Conservative estimates suggest that it should be supplied to meet the energy needs of the human population, which doubled between 2000 and 2040, tripled in 2070 and quadrupled in 2100. This means that $CO_2$ emissions will increase from 6 billion tons in 2000 to 20 billion tons in 2100. Consequently, this shows that $CO_2$ emissions will have a negative impact on the climate. [4].

The past five hundred years have witnessed an unprecedented ascendancy of human domination. In 1500, there were about 500 million homo sapiens in the world. Today, this number is 7 billion. While people consumed 13 trillion calories of energy per day in 1500, today's energy consumption was 1500 trillion calories per day. [1].

According to some forecast models, the price of oil, which is about $ 100 a barrel today, can reach up to $ 200 in the period 2020-2030. If a large part of this rent is invested in state funds each year, in the period 2020-2030 these state funds will be 10-20% of the world's total capital. He may have more than one. There is no economic law that would prevent such a course. It all depends on supply and demand, on the discovery of new oil reserves or new energy resources, or on how well people can get used to a life without oil [5].

### 2.2. COMPETITION BETWEEN BIOFUELS AND FOSSIL FUELS: IS THERE A GREEN PARADOX OR NOT ?

The global damage caused by food wars may overshadow the damage of global warming.The climate is changing, the world is warming, and the increasing need for energy causes more carbon emissions.To slow down this trend, policies that encourage the use of diesel engines, strengthening the insulation of buildings, and more use of green energies such as solar and wind are required.

The current policies to reduce global warming are insufficient and they are downright harmful under some policies such as promoting the use of biofuels.The green paradox emerges at this point; the expectation that fossil-based energy consumption will actually accelerate climate change.

Resource owners increased their production capacities and increased their extraction speed, so they tried to monetize their resources before it was too late. As a result, more fossil carbon was released, burned, and entered the atmosphere, accompanied by falling prices. We call this the green paradox. [6].

Global energy demand is forecast to double by 2050.Even more serious, the European Community is already dependent on oil for 90% of its transport needs. We show that subsidies for renewable energy policies with the intention of encouraging substitution away from fossil fuels may accentuate climate change damages by hastening fossil fuel extraction, and that the opposite result holds under some specified conditions. [7].

In sum,if backstops are already used and more backstops become economically viable as the price of fossil fuels rises, a lower cost of the backstop will either postpone fossil fuel exhaustion or leave more fossil fuel in situ, thus boosting green welfare. However, if a market economy does not internalize global warming externalities and renewables have not kicked in yet, full exhaustion of fossil fuel will occur in finite time and a backstop subsidy always curbs green welfare [8].

## 3. The US NEW DEAL VERSUS The EU’s NEW GREEN DEAL PLAN

The Great Depression: Black Thursday is the name given to the economic depression that started in 1929 and continued throughout the 1930s. The crisis, which started in North America and Europe, had a devastating effect on the rest of the world.

### *3.1. Great Depression in 1929 and The US’s response :New Deal*

The most affected countries were the industrialized countries. Industrialized countries were the most affected by the Great Depression. Construction activities ceased in many countries affected by the crisis; The 40-60% decline in agricultural product prices adversely affected farmers and rural populations.

In 1932, during the economic crisis, F.D. Roosevelt won the presidential election in the USA. All of the economic, social and political measures implemented by the new president Roosevelt, who took office from the president of the Republican Party, Hoover, to get the US economy out of the depression are called the "New Deal."

The Federal Government raised prices for farmers through a Federal Farm Board, created in 1929. But it was only after protest and political engagement under the Agricultural Adjustment Act of 1933 and again in 1938 that the government expanded its programs to store and distribute that food [9].

Nowadays,according to some economists like R. Gordon, the growth rhythm in production per capita is doomed to slow down gradually in the most developed countries, especially in the US, and is likely to hover below 0.5% per year between 2050 and 2100. It is impossible for a 1.2% increase unless new energy sources are used instead of rapidly depleting hydrocarbon energy resources [5].

### *3.2 Todays Modern New ''Green Deal'' of the EU*

Franklin Delano Roosevelt's New Deal was created in response to a then unprecedented economic crisis in the US. The current crisis is not driven by climate change, but the European Green Deal could nevertheless support the recovery. Moreover, if the recovery is implemented properly, the economic recovery has the potential to assist the low-carbon transition. The crisis may actually offer a unique opportunity for the EU to live up to the Green Deal's promise of economic modernisation along the Paris decarbonisation objectives, allowing for a rethink of national taxation, innovation, infrastructure, entrepreneurship or the reform of the common agricultural policy [9].


***Figure. 1****. The various elements of the European Green Deal*

**Source Ref**: [10].

According to the Fig.1 above; the European Green Deal sets out a comprehensive strategy for tackling climate and environmental-related challenges. Soils play a central role in achieving the Sustainable Development Goals (SDGs) by 2030 [11].

The recipe for the success of the European Green Deal is as simple as it is breath-taking: to intelligently promote deep decarbonisation by accompanying the economic and industrialtransformation this necessarily implies, and by ensuring the social inclusiveness of the overall process.Should the strategy succeed, the European Green Deal might become a blueprint for other countries and a tangible example that pursuing climate neutrality is technically feasible and economically and politically viable.To be clear, this will not be an easy ride. As in any revolution, there will be winners and losers. What a European Green Deal should do is provide a clear sense of direction to citizens and companies, and put in place mechanisms to ensure that the most vulnerable segments of society are supported and not left behind [12].

The new European Green Deal has the ambition to make the European Union the first climate-neutral continent by 2050. The European Commission presented an ambitious package of measures within the Biodiversity Strategy 2030, the Farm to Fork and the European Climate Law including actions to protect our soils. The Farm to Fork strategy addresses soil pollution with 50 % reduction in use of chemical pesticides by 2030 and aims 20 % reduction in fertilizer use plus a decrease of nutrient losses by at least 50%.

Accordingly,the Biodiversity Strategy has the ambition to set a minimum of 30 % of the EU's land area as protected areas, limit urban sprawl, reduce the pesticides risk, bring back at least 10 % of agricultural area under high-diversity landscape features, put forward the 25 % of the EU's agricultural land as organically farmed, progress in the remediation of contaminated sites,reduce land degradation and plant more than three billion new trees. The maintenance of wetlands and the enhancement of soil organic carbon are also addressed in the European Climate Law. The new EU Soil Observatory will be collecting policy relevant data and developing indicators for the regular assessment and progress towards the ambitious targets of the Green Deal. [13].

Climate-neutral energy infrastructure is one area where investment could particularly make a difference. Electricity grids need to deal with higher shares of renewables in the future, carbon emissions, and hydrogen should be transported from where it can be produced in a carbonneutral way to where it can help sectors decarbonise.

## 4.CONCLUSION

Global governance will also be required for the fast and deep decarbonisation of the world's energy systems, especially in relation to carbon pricing and efficiency standards. In this context the President of the European Commission, Mrs. Ursula vonder Leyen, has outlined her priorities 2019–2024, including her visionfor a greener Europe: "Climate change, biodiversity, food security, defor-estation and land degradation go together. We need to change the way weproduce, consume and trade. Preserving and restoring our ecosystem needsto guide all of our work" .

It is important to rapidly replace fossil fuel use with renewable energy in the transportation sector as well as in the heating and cooling sectors for the success of the climate strategies of cities .On the other hand,in cities such as Hamburg, San Francisco and Shanghai, there is a direct relationship between the acceleration of the fight against climate change and the increase in the use of renewable energy in all sectors. City governments tighten rules for buildings and enforce renewable energy obligations. The most important of the decisions made by the cities is to determine the termination date of natural gas, oil and coal.

Finally,EU's efforts alone are not enough to solve environment problems like global warming and climate change. We think that,in order to find solution both green paradox and global warming problems EU and its member states and institutions should focus on transformational technologies, and for example go big on low-carbon infrastructure, efficient buildings, and lead markets to boost demand for climate-neutral industry.

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# Environmental Management Planning and Policies of Marine Pollution at the Canakkale Strait (Dardanelle)

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***Abstract***

*The Istanbul Strait (Bosphorus), the Canakkale Strait (Dardanelles), and the Marmara Sea are the components of the Turkish Straits Sea Area-TSSA, one of the most significant sea routes used for global maritime transport. Turkish Straits Sea Area, from past to present, has historical, geopolitical, geographical, strategic, and economic significance.* The Turkish Straits management and control issues have been passed to the Republic of Turkey with the adoption of the Montreux Convention in 1936. *The Turkish Straits are a natural waterway that is unique in the world. There are settlements on two sides of both Istanbul and Çanakkale Straits, and transportation provides by bridges that provide land passage. The control and maintenance for maritime safety and management processes such as local shipping traffic between the two coasts, innocent transit in international maritime transport, security navigation, and marine environmental management are under the authority of the Republic of Turkey. With the increased factor of energy transportation from the Black Sea recently, the Turkish Straits have gained more importance. This study is trying to explain Environmental Management Planning and Policies of Marine Pollution by Ship transportation at Canakkale Strait.*

**Keywords:** Turkish Straits Sea Area (TSSA), Çanakkale Strait (Dardanelle), Oil Pollutions, Collusion, MARPOL

## 1.INTRODUCTION

The Republic of Turkey has a significant geopolitical and strategic position. Due to the straits, Turkey connects the continents of Asia and Europe. Also, the Turkish Straits are consisting of three major elements; Istanbul, Canakkale Straits, and the Marmara Sea. The Straits are a great example of the natural seaway of the world. Well-known Bosporus and Dardanelles names came from ancient times [1]. And these terms are not used anymore by Turkish authorities on the charts with geographic names. the Turkish strait sea area's all parts belong to the sovereign sea territory of Turkey and subject to the regime of internal waters by UNCLOS sentences. The Turkish Strait Sea Area is the most suitable and safe waterway in the region between the Mediterranean and the Black Sea due to its very important recent energy transportation. From 1936, The Turkish Straits, have been begun to govern by the Montreux Convention. The Montreux Convention has treaty obligations. Due to the obligation Republic of Turkey gave annual reports to the League of Nations Secretary-General firstly. Then since 1945, gave these reports to the United Nations Secretary-General. Reports had consisted of general information about straits and navigational safety etc. These reports, which also go to the High Contracting Parties, are entitled,'Rapport Annuel sur le Mouvement des Navires a Travers les Detroits Turcs' (Annual Report Concerning the Movement of Ships through the Turkish Straits). A very important detail in favor of using the expression the 'Turkish Straits' came from a United Nations document. This document belongs to the Third United Nations Conference on the Standardization of Geographical Names. This conference was held in Athens, in 1977, by 152 attended participants representing 59 countries, with observers from 11 non-governmental and international scientific organizations. The main aim of the Conference was to

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use national names to standardize the names of geographical locations. The resolutions of the conference empower Turkey in the use of the name 'Turkish Straits'. [3,4]. This conference's result document's title is proof of the international credence of the expression 'Turkish Straits'. [2,3,5] In recent years straits are the most important trade way of the world cause of the oil and oil products due to the energy transportation importance. Throughout recorded history, due to the strategic location has lead to conflicts between Turkey and the countries that were interested in the Black Sea in terms of political, economic, and trade interests. Nicolae Titulescu who was representative of Romania, expression “Straits are the hearts of Turkey, but also lungs of Romania” affirms the importance of the Straits in Montreux Conference. [3,7] Turkey is in the middle latitudes. So, it could easily feel like 4 season and their effects. Due to this reason, The Turkish Straits Sea Area has very special conditions in terms of the marine environment which includes atmospheric and oceanographic conditions, plant and animal diversity, and also the terrestrial environment. Many different marine species and fishes live and use straits for migration. Due to this condition, the area also has roles as a biological corridor and biological barrier between the Mediterranean Sea and the Black Sea and forms an acclimatization useful zone for migrating species. The Turkish Straits have been exposed to dense marine traffic for centuries and a substantial increase has occurred in size and tonnage of the ships passing through the Straits with hazardous cargo varieties and amounts they carry by the neighboring Black Sea states and the Central Asian Turki Republics.Recently increase in the number of vessels that navigates on the Straits and being on the transportation way of hazardous goods pose serious environmental and safety hazards for the Turkish Straits Sea Area and its surrounding residential areas. High density of marine traffic effects on straits, makes the navigation rather difficult. The Straits have faced many casualties, collusions that caused severe environmental problems due to oil spilling [3,8].

*Fig. 1 The Turkish Strait Sea Area overview from paper chart number TR29.*

## 2. THE CANAKKALE STRAIT OVERVIEW

The Canakkale Strait is one of major components of Turkish Strait Sea Area(TSSA). Canakkale strait is almost 20 NM longer than Istanbul strait. Canakkale's Morphological and geographical status is quite different of Istanbul strait [9]. The surveyed current direction of the Çanakkale Strait is NE-SW. Between the Biga and Gelibolu peninsula areas are very narrow.[10,16] From Anafartalar to the north and the Biga ridge to the south of the Çanakkale Strait has an average depth of -55 meters and reaches a depth of -90 meters. [16] Çanakkale Strait constitutes 22% of the Turkish Straits Sea Area and the sea traffic separation lane is limited to 40 ° 26',00 N - 026 ° 45',25 E and 40 ° 01',52 N - 026 ° 11',18 E and has shown the Maritime Traffic Regulations for the Turkish Straits. The Canakkale Strait is defined between the longitude passing through Zincirbozan Lighthouse in the north and the line between Mehmetçik Cape Lighthouse - Kumkale Cape Lighthouse in the south [16].

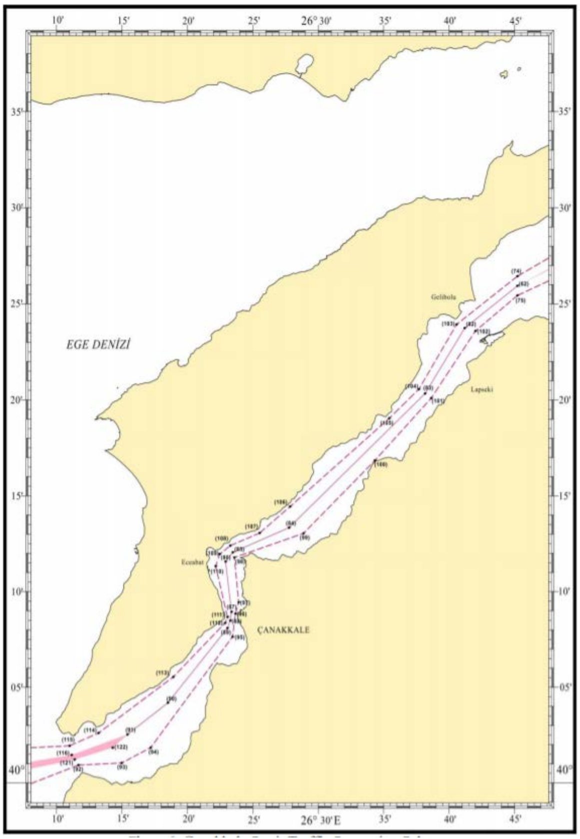


*Fig. 2 The Çanakkale Strait Traffic Seperation Scheme*

Çanakkale Strait has a different geography status than the Istanbul Strait. And also Canakkale straits length is 2 times longer than the Istanbul. But Canakkale's geomorphological structure, it has a rugged structure on the north and south line.

## 3. THE CANAKKALE STRAIT’S MARINE SCIENCE INFORMATIONS

The Canakkale Strait constitutes 22.56% of the Turkish Straits' sea area. Kilitbahir and Çanakkale point is the narrowest part at the strait with1300 meters, the shore of Intepe and Domuz Dere is the widest part with 8135 meters. Not only The Istanbul Strait but also Canakkale Strait has two different currents. Both two strait's first current face is the surface current which comes from the Black Sea to the Aegean Sea through the Marmara Sea. and the second face or water collum the undercurrent coming from the first layer that the Mediterranean and passing through the Aegean Sea towards the Marmara Sea direction. Altough nearly 600 km3 of water lost annually(surveyed) by surface current coming from the Black Sea, it gains approximately 300 km3 of water per year thanks to the undercurrent coming from the Mediterranean Sea via the Turkish Straits. [13,16]. The surface current values between Marmara Sea to the Aegean Sea, are 0.5 and 5 knots. According to hydrographic surveyed that the this area's current speed reaches 2 knots per hour at Gelibolu. With geographic status and meteorological effects south side of Nara Cape and in front of Kilitbahir point, current value is 5 knots. Especially between Çanakkale with Kepez area current value is also strong.

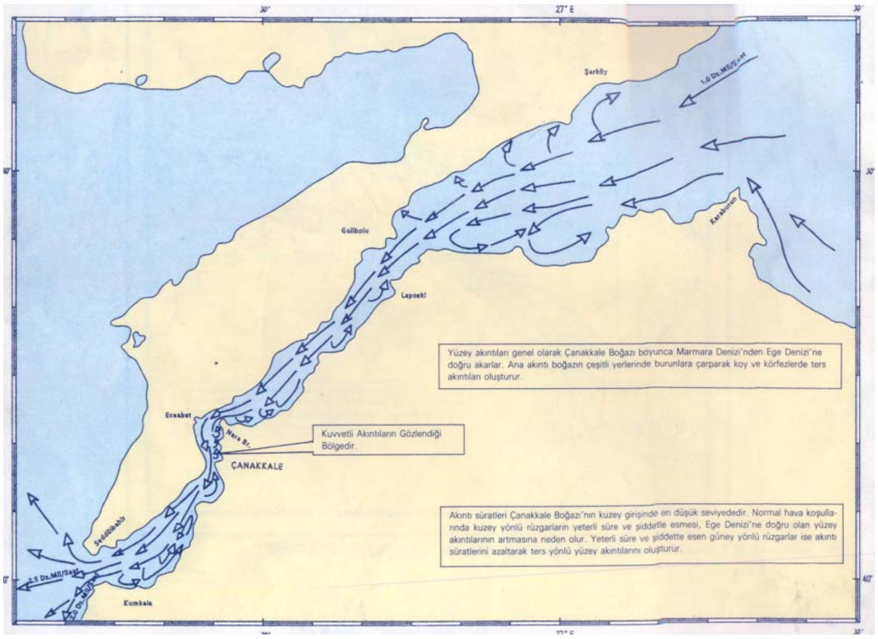


*Fig. 3 TN-ONHO Canakkale Strait's current chart.*

*Table 6.Surveyed Wind general values of Canakkale city by Ministry of Environment and Urbanisation [17].*

| MONTHS | Average wind speed (m/s) | Fastest wind direction | Fastest wind speed (m/s) | Average number of stormy days | Average number of days with strong winds |
|---|---|---|---|---|---|
| NOV | 3,8 | N | 20,6 | 1 | 18 |
| DEC | 2,8 | SSW | 14,9 | 0 | 7 |
| JAN | 4 | S | 22,1 | 4 | 14 |
| FEB | 4,1 | NE | 19,5 | 4 | 11 |
| MAR | 3,9 | NNE | 19 | 1 | 15 |
| APR | 3,1 | SSW | 20,1 | 1 | 9 |
| MAY | 3,2 | S | 15,9 | 0 | 8 |
| JUN | 2,9 | NNE | 17 | 0 | 12 |
| JUL | 3 | NNW | 16,5 | 0 | 19 |
| AGU | 3,7 | NNE | 14,9 | 0 | 22 |
| SEP | 3,3 | ENE | 14,9 | 0 | 19 |
| OCT | 2,7 | WNW | 23,7 | 1 | 13 |

When northerly winds blow, the speed of the upstream increases. The excess water of the Black Sea reaches the Aegean with the discharge current of the upper current; To compensate for this, the intense Mediterranean-origin waters enter the Marmara with the undercurrent. While the dominant wave direction of the upper current is in the North direction in January and February, it is in the North direction in general besides being South direction from time to time due to the Lodos wind in April. In other months, since the effect of the Northwind is not as effective as in the winter months, the dominant wave directions in the Northeast direction are determined by the general Northeast direction of the strait. Wavelengths are generally 0.6 m. However, maximum values are reached in March, and wavelengths of 3-9 m are detected. The main factor in this change is the hydrological increase in the stream-based water inputs around the Black Sea.

The salinity effect is also an important issue at Canakkale Strait. The especially first layer is the surface current coming from the Black Sea that reaches the entrance of the Çanakkale Strait. Also, the value takes from 16-17 to % 22-26 with the effect of the Marmara Sea salinity ratio. On the other hand, the salinity value observed to be %27-28 in the middle of Canakkale Strait, it reaches % 33 towards the south area. The salinity ratio value of the Mediterranean between the southern exit of the Çanakkale Strait reaches up to % 36-37. The first layer is the current surface is also affected by meteorology. It shows effect via wind. Two directions are important for current effects that North-Northeast and South-Southwest.

## 4.CANAKKALE STRAIT OIL SPILL RESPONSE POSSIBILITES OVERVIEW

In the Turkish territorial waters safety responsible is Directorate of Coastal Safety. The Directorate is working under Ministry of Transportation and Infrastructure. And Their mission is to assist and improve the safety of navigation in Turkish Territorial Waters. The objectives of coastal safety assists the cruise security of Turkish and foreign flagged ships sailing in our seas and territorial waters, provides coastal safety and ship rescue services, pilotage, tugboat services and sets up and operate their related devices and facilities, saves lives, goods and ships, helps, tow, removes shipwrecks and carry out towage and diving services related to them, makes and operates all kinds of investments related to coast radio stations, Automatic Identification System, dGPS and similar systems established and establishes for safe navigation and to increase the safety of navigation. The existing response equipment to marine pollution that may occur after marine accidents in the Canakkale Strait is as below; A total of 3 open sea barriers, 2 port barriers, 4 skimmers and 5 Sea Slug are among the vehicles to be used in a possible marine pollution, 2 of which are standard, 1 of which is inflated. All of the opportunities for response to marine pollution for the Canakkale Strait, are established at the station in Akbaş. In addition, there is an Trash and Debris Boom (Open Sea Purpose) for intervention in Lapseki, which is the entrance of the Canakkale Strait from The Marmara Sea. And also all these solution materials are on Akbaş Rescue station.

*Fig. 4 Boom equipment example*

*Fig. 5 Port / Harbor Offshore Barriers.[18]*

## 5.ENVIRONMENTAL MANAGEMENT PLANNING AND POLICIES IMPORTANCE

From the General Directorate of Coastal Security statistics, a total of 43.759 ships in 2019 and also a total of 42.036 ships have passed at Canakkale Strait in 2020. Also, the same Directorate statistics, more than 60 accidents have occurred in and around the Çanakkale Strait end of the 2019. 8 of accidents occurred in north entrance, 16 of them in south point and 36 numbers of them in the middle of the Canakkale Strait.

It is one of the important policies to make an effective fight against marine pollution and to protect natural resources, not to disturb the marine ecological balance, and to coordinate with the relevant institutions / organizations and municipalities at the regional and national level.

Also in the Official Gazette dated 24/6/1990 and numbered 20558 It has become a party to MARPOL 73/78 (International Maritime Convention for the Prevention of Pollution of the Seas by Ships) with the published convention. With the paragraph (ö) of the 3rd clause of the 5th article of the second part of the Waste Management Regulation, which came into force by being published in the Official Gazette dated 02.04.2015 and numbered 29314. It is forbidden to pollute the environment by pouring into the soil, seas, lakes, streams and similar receiving environments, directly filing and storing has, a provision. As it is known, in subparagraph (h) of Article 9 of the National Environmental Law No. 2872, “The country's by protecting sea, underground and surface water resources and aquaculture production areas. It is essential to ensure that it is used and protected against pollution”.

Also, in Article 8 “All kinds of wastes and residues, in a way that will harm the environment, as determined in the relevant regulations. to give directly or indirectly to the receiving environment in violation of the standards and methods,It is forbidden to store, transport, remove and engage in similar activities.” place for judgment is given. Below at Table 2 shows marine environment regulation list that use for protect seas and oceans.

*Table 7. Marine Environment Regulations (https://www.iaphworldports.org/legal-database-on-international-maritime-conventions-impacting-on-ports/maritime-environment)*

| |
|---|
| Int. Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties, 1969 |
| Convention on the Prevention of Marine Pollution by Dumping of Wastes and other matter, 1972 |
| Int. Convention for the Prevention of Pollution from Ships of 1973 MARPOL73/78 |
| United Nations Convention On the Law of the Sea, 1982 |
| Convention on Biological Diversity-1993 |
| Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances, 2000 |
| International Convention on the Control of Harmful Anti-Fouling Systems on Ships, 2001 |
| Convention on the Protection of the Underwater Cultural Heritage 2001 |
| IMO Resolution A 949(23) guidelines on places of refuge for ships in need of assistance, 2003 |
| International Convention for the Control and Management of Ships Ballast Water and Sediments, 2004 |
| Nairobi International Convention on the Removal of Wrecks, 2007 |
| Hong Kong International Convention for the Safe and Environmetally Sound Recycling of Ships,2009 |

As described in section 4, there is a station that working for oil spill prevention at Akbaş position. This station placed in the middle of the Canakkale Strait. Geography, meteorology status, and surface layer current affect negatively the operation.

## 6.CONCLUSION AND RESULTS

According to the general studies and the results obtained from the simulation applications with the data in hand, possible marine accidents in the Dardanelles will cause significant damage. In particular, the increase observed in chemical cargo transportation and tanker usage, which has increased due to energy transportation, has focused attention on chemical tankers. Result of a possible chemical tanker accident, it is very significant to intervene in the accident as soon as possible, depending on the place and region of the accident. In the geographical limitation observed in the Dardanelles, it is difficult to intervene when an accident occurs on the Nara-Eceabat and Kilitbahir-Çanakkale lines, which are the narrowest region in the valley structure and where the current density increases. In rapid intervention, The European side of the Canakkale strait should be protected by coastal protection barriers. In addition, for the shores of the Anatolian side of the Canakkale Strait, the Kepez region should be protected with coastal barriers. Especially in accidents that cause marine pollution, it is necessary to contain the oil with a floating fence barrier or inflatable fill barrier to reduce the spill effect. In this way, it will be possible to clean the sea. In case of a possible maritime accident in the Canakkale Strait, the Ministry of Interior, Coast Guard Command intervenes with the equipment available in the Lapseki station (except for the open sea barrier) and with the possibilities and capabilities of the Ministry of Transport and Infrastructure, General Directorate of Coastal Safety in the Akbaş station. In this context, considering these two stations and their facilities, it is recommended to establish stations in other places, although they have good opportunities.

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