Yeditepe University Civil Engineering Department
CE 492 Engineering Project
Proposal Form

Supervisors Name/s	Dr. öğr. Üyesi Günseli Erdem Altın; Doç. Dr. Gülten Polat
Project Title	Advanced Statistical Modelling of Long-Term Meteorological Data (1960–2025) for Climate Change Assessment and Engineering Relevance
Project Reference No*	
Relevant course/s for the project	CE351, CE354, CE 363, CE 452, CE 455, CE 488

Project Summary:

This project aims to create a scientifically sound and engineering-focused framework for analyzing and modelling long-term meteorological data (1960-2025) from Turkish State Meteorological Service (TSMS) for the Muğla region. Rather than viewing climate data as merely descriptive environmental records, the study interprets meteorological variables as engineering-relevant parameters that directly affect the safety, durability, serviceability, and resilience of civil infrastructure.

The project will also include data-driven modelling methods to enhance comprehension of the temporal development and predictive behaviour of essential meteorological variables, alongside statistical characterization. Advanced statistical and time-series techniques will be used to quantify long-term trends, variability patterns, and extreme events in precipitation, temperature, wind speed, humidity, and atmospheric pressure. To estimate future variability and the probability of extreme events, these analyses will be supplemented with predictive modelling techniques, including regression-based models, stochastic simulations, and machine-learning methods where applicable.

The combined statistical and modelling framework will allow:
- Identification of long-term climate trends and structural changes,
- Quantification of uncertainty and variability in engineering-relevant parameters,
- Estimation of return periods and extreme-event probabilities,
- Development of predictive scenarios for infrastructure planning.

These results will provide engineering-relevant insights for:
- Hydrological design parameters,
- Load assumptions in structural engineering,
- Durability and material performance assessments,
- Climate-resilient and sustainability-oriented infrastructure planning.

Project Achievements:
(Please explain how the proposed project helps to achieve the performance criteria listed below)

Identifying specific <u>design objectives</u> based on project requirements:	1) Long-term meteorological datasets (1960-2025) will be compiled from Turkish State Meteorological Service (TSMS), cleaned, and quality-controlled. 2) Statistical characteristics of key meteorological variables will be determined on daily, monthly, and annual bases. 3) Climate trends, seasonal variability, and anomalies will be identified using appropriate statistical methods. 4) Predictive models will be developed to estimate future variability and extreme-event behaviour. 5) The implications of observed meteorological trends for structural loading, hydrological design, and environmental applications will be discussed.
Gathering and using relevant information	1) Turkish meteorological data will be obtained from official national databases (e.g., TSMS) and verified institutional sources. 2) Data preprocessing steps such as missing data treatment, outlier detection, homogenization, and consistency checks will be applied. 3) Statistical tools including trend analysis, variability analysis, extreme value analysis, and correlation analysis will be employed. 4) Time-series and regression-based models will be used to evaluate temporal evolution and predictive behaviour. 5) Results will be interpreted in the context of climate change, hydrology, and engineering relevance.
<u>Analyzing alternatives</u> using appropriate engineering knowledge	1) Different statistical and time-series analysis techniques will be compared. 2) Alternative approaches for trend detection (e.g., linear regression, Mann–Kendall test) and extreme-event analysis (e.g., GEV, Gumbel) will be evaluated. 3) Predictive modelling alternatives (e.g., regression, ARIMA-type models, or machine-learning approaches) will be tested for selected variables. 4) The strengths and limitations of each method will be discussed based on accuracy, robustness, and engineering applicability. 5) The most appropriate modelling approach will be selected according to engineering design requirements.

Considering the relevant constraints in the design: *(Please explain how the proposed project considers one or more limitations listed below)*

Economy	Open-access meteorological datasets will be used to eliminate data acquisition costs. Efficient statistical and computational methods will be selected to reduce processing time and operational expenses. The proposed modelling approaches will be evaluated in terms of computational cost versus predictive performance.
Environmental Issues/Sustainability	The study will contribute to understanding long-term climate behaviour and its environmental implications. Results will support climate-resilient engineering design and sustainable infrastructure planning. The effects of changing meteorological conditions on water resources, structural loads, and environmental safety will be discussed.
Applicability	The developed statistical and predictive models will be applicable to engineering design parameters such as rainfall intensity, temperature variability, and wind loads. The methodology can be adapted to other regions with similar climatic conditions. The usability of the results for engineering, environmental, and planning purposes will be evaluated.

Definition of outcomes linked to the objectives of projects	At the end of the project, students are expected to: 1. Apply knowledge of mathematics, statistics, and engineering to real meteorological datasets. 2. Identify and analyze engineering-relevant climate-related problems. 3. Develop and compare alternative statistical and predictive models. 4. Use modern computational tools and data-analysis software. 5. Collect, process, and interpret real-world environmental data. 6. Integrate individual analytical work within a structured project framework. 7. Prepare technical reports and oral presentations in English. 8. Access scientific literature and follow current developments in climate and engineering research. 9. Demonstrate awareness of professional and ethical responsibilities. 10. Gain basic experience in project planning, time management, and risk assessment. 11. Understand the impact of engineering decisions on environment, safety, and society. 12. Become familiar with project evaluation, tendering, and cost considerations. 13. Recognize the interaction between design, analysis, and practical engineering applications. *(Minimum requirements are;* o *project timeline,* o *abstract,* o *Türkçe özet,* o *the definition of the problem,* o *the scientific information and literature review,* o *different design alternatives and decision criteria,* o *selection of optimum alternative* o *economical, sustainability, ethical issues* o *engineering drawing and demonstration methods while presenting the solution* o *appendix including standards, patents, brochures etc.)*

Approval of the Project	**Approved** ☐	**Not Approved** ☐
State the reason(s) if not approved:		
Department Chair: Asst. Prof. Dr. Özgür Köylüoğlu		Signature

* Project Ref.Numbers will be given by the Engineering Design Project Committee