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Predictive Analytics of Climate Stress Impact on the Italian Mediterranean Buffalo: Physiological and Productive Responses

keywords ARTIFICIAL INTELLIGENCE (/pls/portal30/sviluppo.tesi_proposte.list_kwd?w=ARTIFICIAL INTELLIGENCE&l=EN), CLIMATE CHANGE (/pls/portal30/sviluppo.tesi_proposte.list_kwd?w=CLIMATE CHANGE&l=EN), DATA ANALYTICS (/pls/portal30/sviluppo.tesi_proposte.list_kwd?w=DATA ANALYTICS&l=EN), MACHINE LEARNING (/pls/portal30/sviluppo.tesi_proposte.list_kwd?w=MACHINE LEARNING&l=EN), PRECISION LIVESTOCK FARMING (/pls/portal30/sviluppo.tesi_proposte.list_kwd?w=PRECISION LIVESTOCK FARMING&l=EN)

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Research Groups DAUIN - GR-06 - ELECTRONIC DESIGN AUTOMATION - EDA (/pls/portal30/sviluppo.tesi_proposte.list_grprc?g=DAUIN - GR-06 - ELECTRONIC DESIGN AUTOMATION - EDA&l=EN), EDA Group (/pls/portal30/sviluppo.tesi_proposte.list_grprc?g=EDA Group&l=EN),

Thesis type EXPERIMENTAL

Description

Climate variability is a critical factor influencing both the productive performance and welfare of dairy livestock. In Mediterranean buffaloes, which are highly sensitive to heat and cold stress, milk yield, milk composition (fat, protein, lactose), and animal health parameters can be significantly affected by environmental fluctuations. With the increasing availability of open-access climate datasets, such as NASA POWER, it is possible to retrospectively and prospectively analyse the impact of climatic conditions on buffalo production systems by combining farm-level data with satellite-derived weather records [1]. The real-world challenge consists of identifying how climatic indices (e.g., THI – Temperature-Humidity Index, cold stress indices, heat load indices) are associated with fluctuations in production and welfare parameters at the farm level [2, 3, 4]. The use of a statistical environment allows automated extraction of historical climatic data (based on farm latitude and longitude), their aggregation into daily/monthly indices, and their integration with milk production and quality datasets. This dissertation project will experimentally apply this methodology to one or more buffalo farms, collecting production and welfare data (milk yield, fat %, protein %, somatic cell count, reproduction performance, and health indicators) and combining them with climatic indices retrieved from NASA POWER. The objective is to validate the relationship between climate and buffalo productivity and to highlight thresholds of vulnerability to climate stress.

The aim of the thesis consists of:
1. Collection of farm-level production data (milk yield, fat %, protein %, SCC, reproduction, health records).
2. Definition of climatic indices relevant for buffalo welfare (THI, cold stress indices, wind chill, solar radiation).
3. Retrieval of historical weather data using NASA POWER R package (lat/long-based extraction).
4. Data integration and statistical modelling (mixed models, correlation analysis, regression, machine learning techniques).
5. Identification of thresholds where climate variability significantly affects production and welfare.
6. Build a model able to predict production loss in dairy buffaloes.
7. Discussion of results in the framework of climate resilience and precision livestock farming strategies.

[1] Matera, R., Pierro, F., Santinello, M., Fuintino, A. I., Pacelli, G., Norton, T., & Neglia, G. (2025). Precision livestock farming in buffalo species: a sustainable approach for the future. Smart Agricultural Technology, 101060. https://doi.org/10.1016/j.atech.2025.101060
[2] Matera, R., Cotticelli, A., Gómez Carpio, M., Biffani, S., Iannacone, F., Salzano, A., & Neglia, G. (2022). Relationship among production traits, somatic cell score and temperature–humidity index in the Italian Mediterranean Buffalo. Italian Journal of Animal Science, 21(1), 551-561. https://doi.org/10.1080/1828051X.2022.2042407
[3] Piscopo, N., Matera, R., Cotticelli, A., Trapanese, L., Tamburis, O., Cimmino, R., & Salzano, A. (2024). Investigation of climate effects on the physiological parameters of dairy livestock (cow vs. buffalo). Sensors, 24(4), 1164. https://doi.org/10.3390/s24041164
[4] Petrocchi Jasinski, F., Evangelista, C., Basiricò, L., & Bernabucci, U. (2023). Responses of dairy Buffalo to heat stress conditions and mitigation strategies: a review. Animals, 13(7), 1260. https://doi.org/10.3390/ani13071260

Required skills

Required Technical Skills:
- Knowledge of statistical techniques (e.g., descriptive analysis, inferential analysis, regression)
- Experience with regression, classification, and clustering techniques
- Understanding of supervised and unsupervised learning algorithms
- Proficiency in programming languages (i.e. Python)

Cross-Functional Skills:
- Ability to tackle complex problems and find practical solutions
- Skills in communicating results to various stakeholders (i.e., agronomists)
- Ability to work in multidisciplinary teams, collaborating with experts in agronomy

Deadline 01/09/2026

VISUALIZZAZIONE AGLI STUDENTI

Corso di laurea - Ord. previgente il D.M. 509/99 in INGEGNERIA PER L'AMBIENTE E IL TERRITORIO

Corso di laurea magistrale in AGRITECH ENGINEERING

Corso di laurea magistrale in DATA SCIENCE AND ENGINEERING

Corso di laurea magistrale in ICT FOR SMART SOCIETIES (ICT PER LA SOCIETA' DEL FUTURO)

Corso di laurea magistrale in INGEGNERIA BIOMEDICA

Corso di laurea magistrale in INGEGNERIA DEL CINEMA E DEI MEZZI DI COMUNICAZIONE

Corso di laurea magistrale in INGEGNERIA DELLA PRODUZIONE INDUSTRIALE E DELL'INNOVAZIONE TECNOLOGICA

Corso di laurea magistrale in INGEGNERIA MATEMATICA

Corso di laurea magistrale in INGEGNERIA PER L'AMBIENTE E IL TERRITORIO

Corso di laurea specialistica in INGEGNERIA PER L'AMBIENTE E IL TERRITORIO