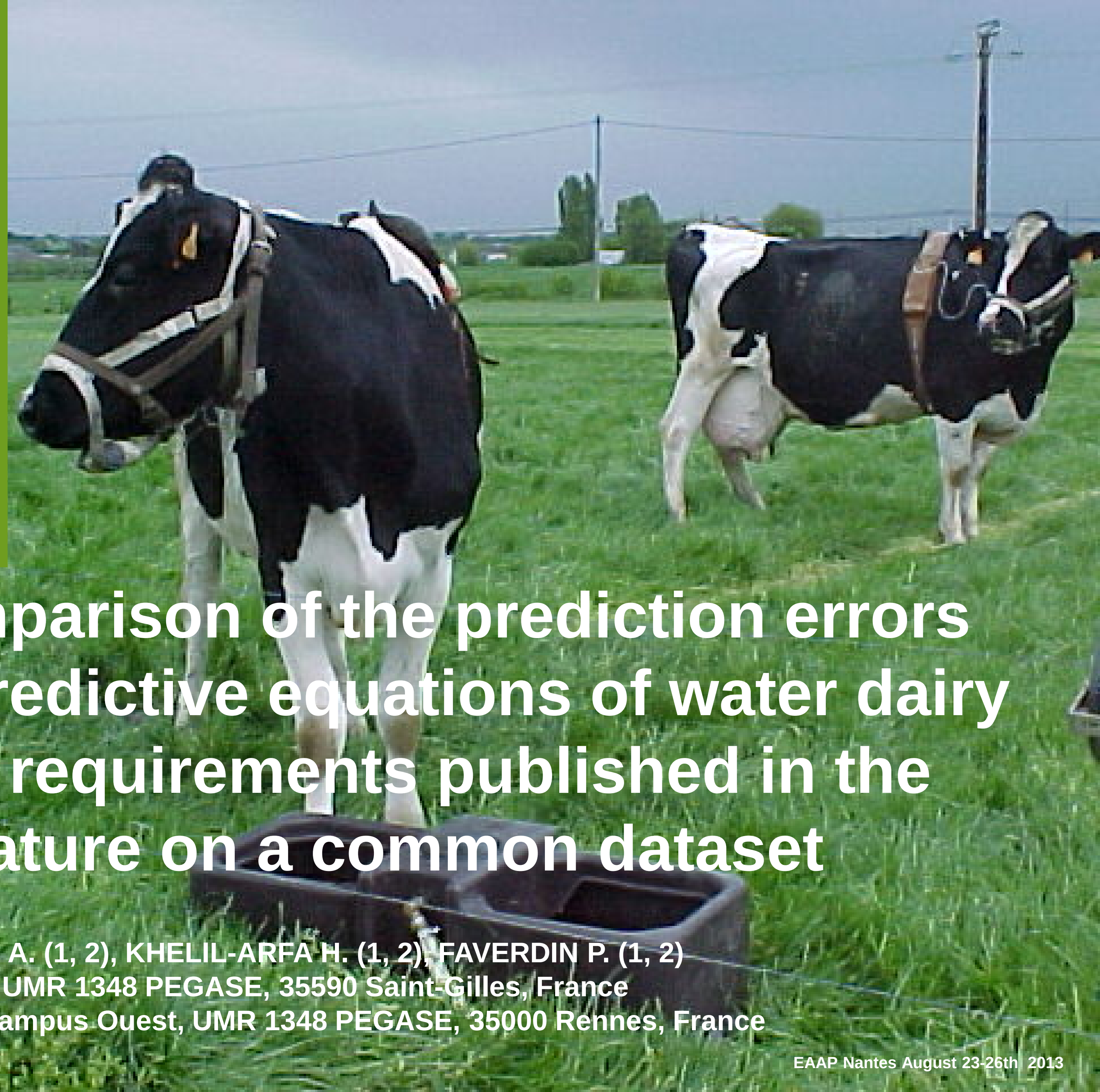

Comparison of the prediction errors of predictive equations of water dairy cow requirements published in the literature on a common dataset

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A need to quantify dairy cows water requirements

Introduction

- French dairy farms = 38 % of water (blue) consumed by agriculture excluding irrigation. 75% of the water is used for watering animals.
- The amount of water offered to the dairy herd cannot be reduced without reducing animal performance and welfare, but the detection of leaks on the water networks can represent a substantiate saving of water at the farm level (Ménard et al 2012).
- Application of the Welfare Quality® protocole to 100 dairy farms in France (De Boyer des Roches et al 2012) : the criteria of absence of prolonged thirst is be very heteogenously respected.

A need to better predict the water requirements of dairy cows

→ (detection of leaks on farm water networks and of situations of water restriction)

Numerous equations published in the literature

Introduction

- Numerous predictive equations of the amount of water drunk by dairy cows, or of the total water intake, published in the litterature (> 30).
- Equations established by multiple regression.
- Number of variables used to establish the equations very variable: from less than 30 data (obtained on experimental groups of animals) to more than 2000 data (individual and daily data).
- Huge variability of the experimental conditions in which the data were obtained (diets, production levels or meteorological conditions).

→ **Objective of this study** : to compare the predictive performances of these equations on a common dataset obtained from published studies.

The compared predictive equations

Materials and Methods

Sources	Place	Equations	
Castle and Thomas (1975)	UK	Drunk Water	= f(MY, %DM)
Little and Shaw (1978)	UK	Drunk Water	= f(DMI, MY)
Stockdale and King (1983)	Australia	Drunk Water	= f(DMI, %DM)
Murphy et al (1983)	Urbana, USA	Drunk Water	= f(DMI, MY, Na Intake, Minimal Temperature)
Holter and Urban (1992)	Durham, USA	Drunk Water	= f(DMI, MY, %DM, Julian Day Rank) Lactating Cows = f(%DM, DMI, %CP, Julian Day Rank) Dry cows
Dahlborn et al (1998)	Sweden	Drunk Water	= f(MY, %DM)
Meyer et al (2004)	Germany	Drunk Water	= f(Daily Average Temperature, MY, LW, Na Intake)
Cardot et al (2008)	France	Drunk Water	= f(DMI, MY, %DM, Minimal Temperature, Rainfall)
Kume et al (2010)	Japan	Drunk Water	= f(%DM, lactating or dry cow)
Khelil-Arfa et al (2012) & Boudon et al (2013)	France	Drunk Water	= f(%DM, DMI, MY, %Conc, LW, Daily Average Temperature)
INRA (1988)	France	Drunk Water	= f(DMI, Ambient Temperature)
Paquay et al (1970a)	Belgium	Total Water Intake	= f(DMI, %DM)
Stockdale and King (1983)	Australia	Total Water Intake	= f(DMI, %DM, Daily Average Temperature)

The compared predictive equations

Materials and Methods

Sources	N	Diet %DM	MY, kg/j	Temp °C
Castle and Thomas (1975)	66	50 (± 22,4)	16.8 (±2,84)	8,2 (± 2.57)
Little and Shaw (1978)	112	87 (± 1.5)	21,4 (± 0,31)	15,0 (± 0,72)
Stockdale and King (1983)	15	30 (± 12,2)		16,7 (± 3,2)
Murphy et al (1983)	76	62 (± 2)	33,1 (6,13)	13,6 (± 6,92)
Holter and Urban (1992) *Lactating cows*	329	50 (± 7,2)	34,6 (± 6,8)	
Dry cows	60	60 (± 24,4)	0	
Dahlborn et al (1998)	24	70 (± 21,8)	25 (± 2,6)	
Meyer et al (2004)	12821	55 (± 9,5)	31,1 (± 7,7)	8,6 (± 7,1)
Cardot et al (2008)	1837	48 (± 5,0)	26,5 (± 5,9)	3.8 (± 4,4)(3)
Kume et al (2010) *Lactating cows*	16	51 (± 9,5)	29,5 (± 3,5)	20 (± 2,0)
Dry cows	30	38 (± 11,0)	0	20 (± 2,0)
Khelil-Arfa et al (2012)	232	61 (± 29,1)	24.9 (± 8,36)	15 (± 2,0)
Paquay et al (1970) TWI	1752	[15-90]	0	
Stockdale and King (1983) TWI	8	46 (± 28,1)		13,2 (± 2,4)

The dataset on which the equations were compared

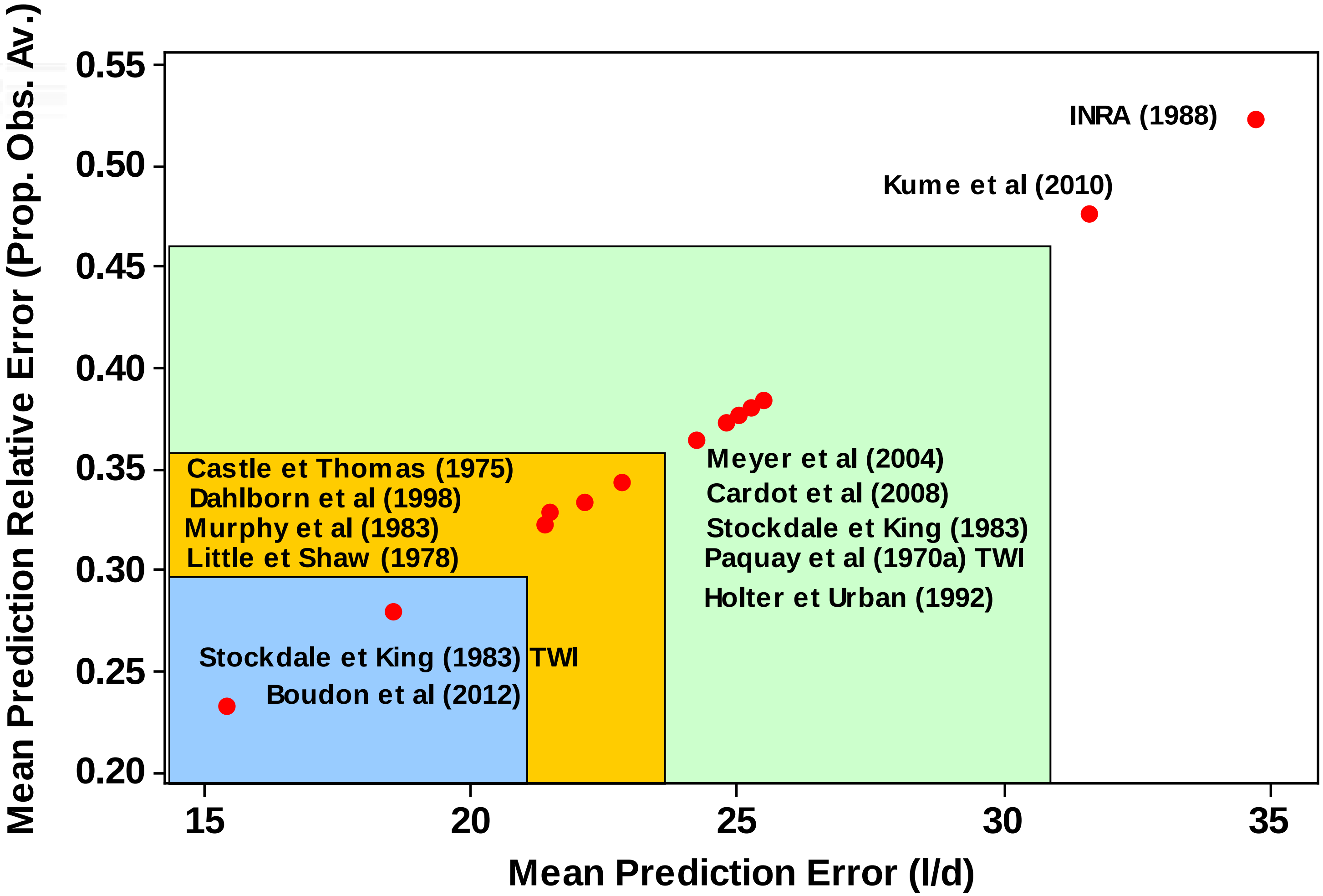
Materials and Methods

- 89 observations of amount of drunk water obtained from groups of cows given a same treatment from 18 studies collected from the CAB with the keywords 'water intake' and 'dairy cows'.
- Data that could have been used to establish one of the 13 compared equations were not included.
- 75 observations with lactating cows et 54 observations with an ambient temperature exceeding 15°C.

	Mean	Min	Max
Dry Matter Intake (kg/j)	15,7	5,3	27,1
Milk Yield (kg/j)	21,5	0	41,5
Daily drunk water (l/d)	66,5	10,9	128,0
Diet Dry Matter Content (g/100 g)	54,8	37,9	86,0
Concentrate proportion (g/100 g)	45,1	0,0	70,0
Diet CP content (g/100 g MS)	14,4	3,5	19,8
Daily av. of Ambient Temperature °C	21,3	5,0	36,0

Root Mean Square Prediction Errors (RMSPE)

Results



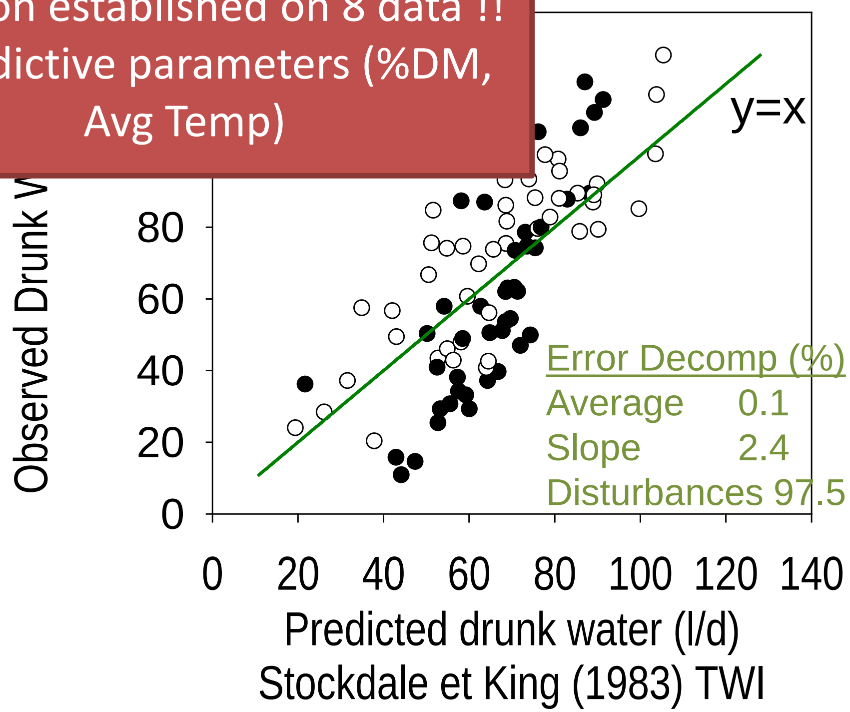
Relative MSPE	Lower than 30%	Between 30 and 35%	Between 35 and 40%	Higher than 45%

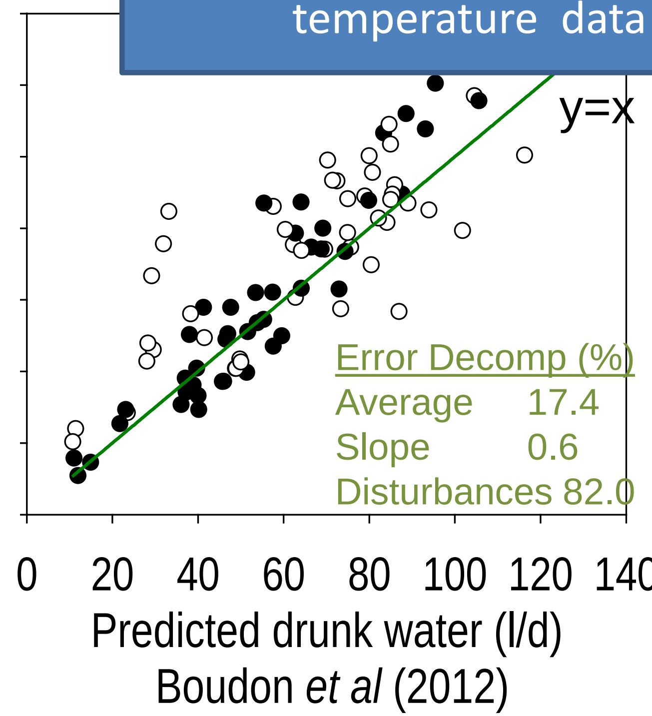
Predictive equations with a relative RMSPE lower than 30%

Results

Equation established on 8 data !!
2 predictive parameters (%DM, Avg Temp)

A slight underprediction of water requirements with high temperature data



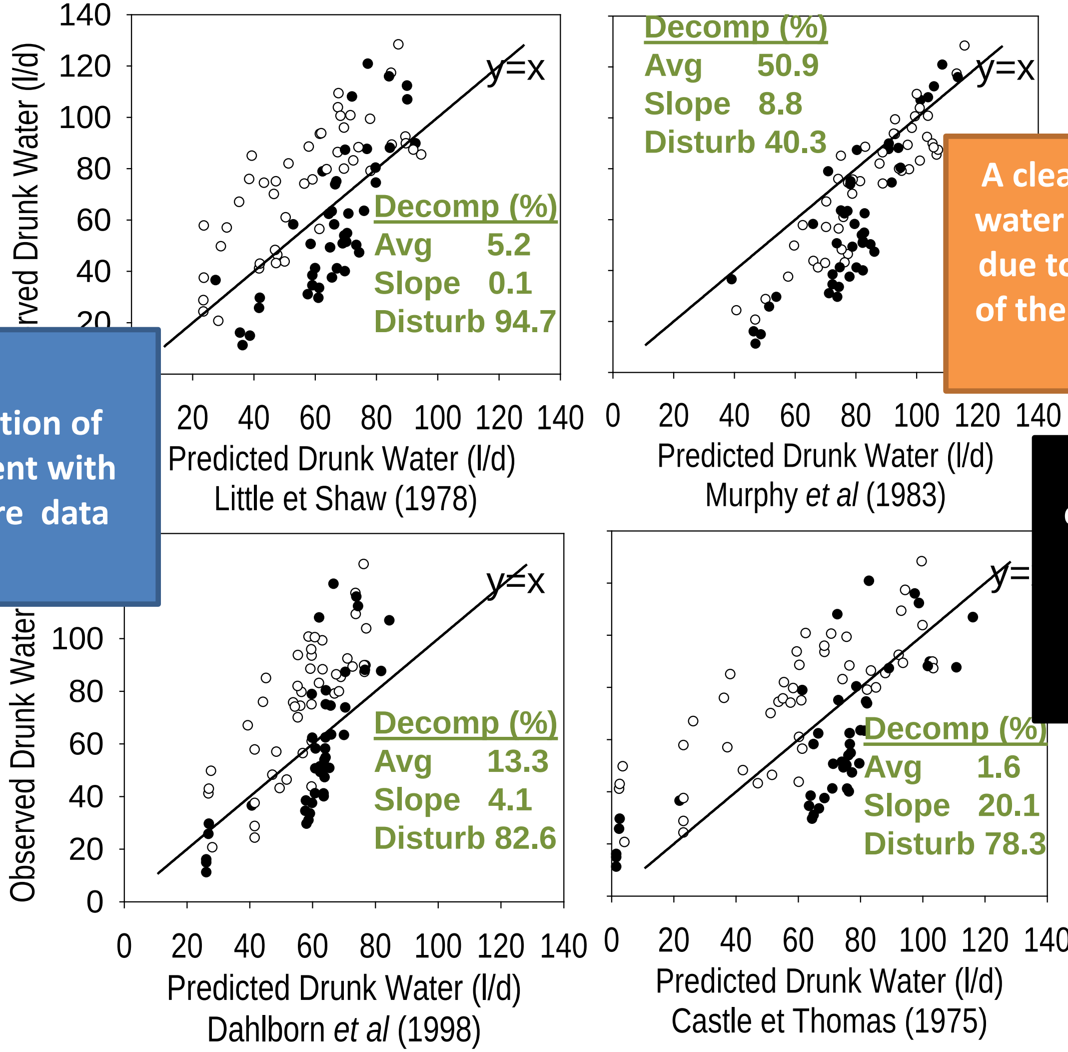


- ● Thermoneutral conditions (d15°C)
- ○ Average daily temperature >15°C

Error decomposition according to Bibby et Toutenburg (1977)

Predictive equations with a relative RMSPE between 30 and 35%

Results



An underprediction of water requirement with high temperature data

A clear overprediction of water requirements likely due to an overestimation of the daily amount of Na intake

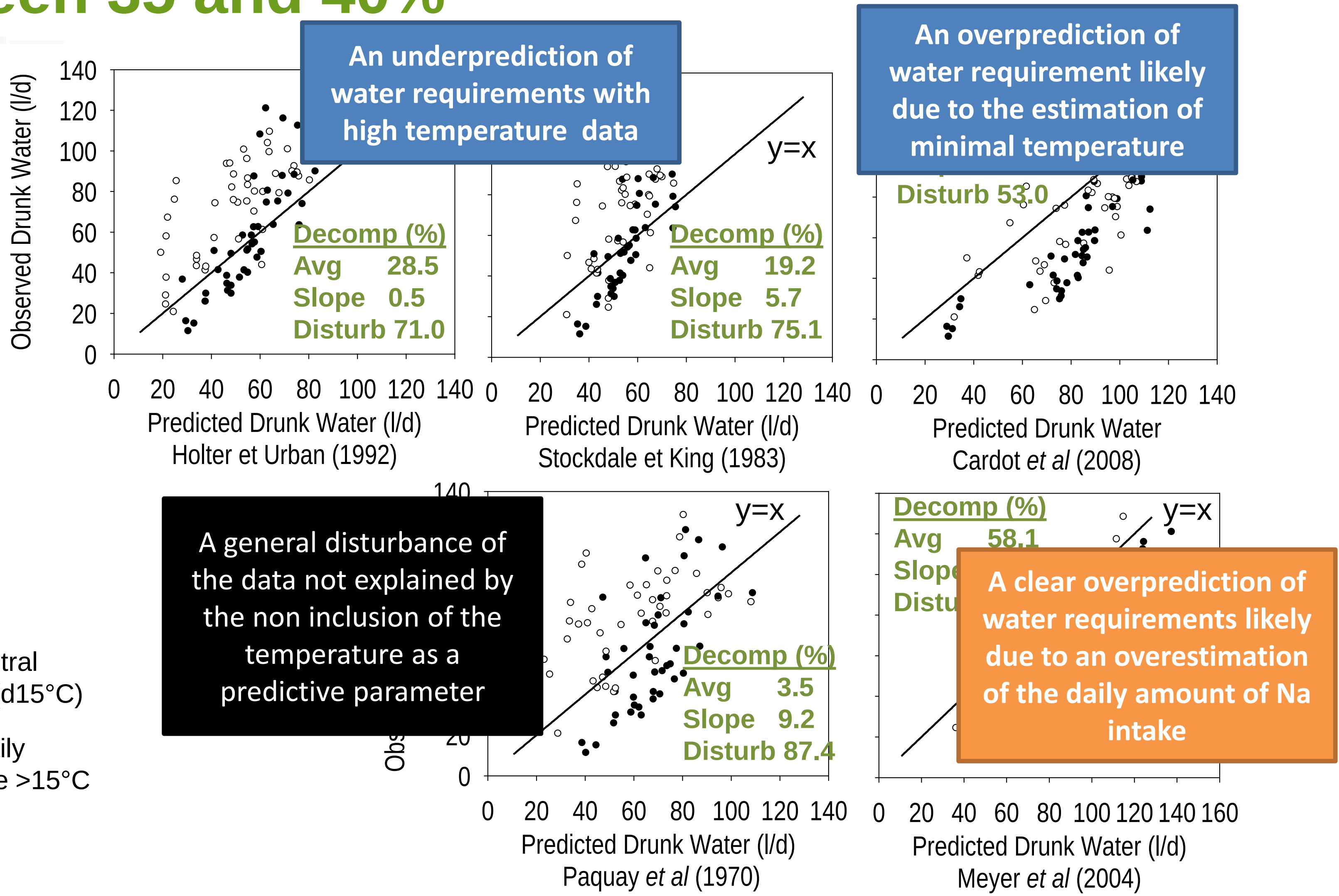
A biais on the slope (not explained by the fact that temperature was not included as a predictive parameter in this equation)

● Thermoneutral conditions (d15°C)

○ Average daily temperature >15°C

Predictive equations with a relative RMSPE between 35 and 40%

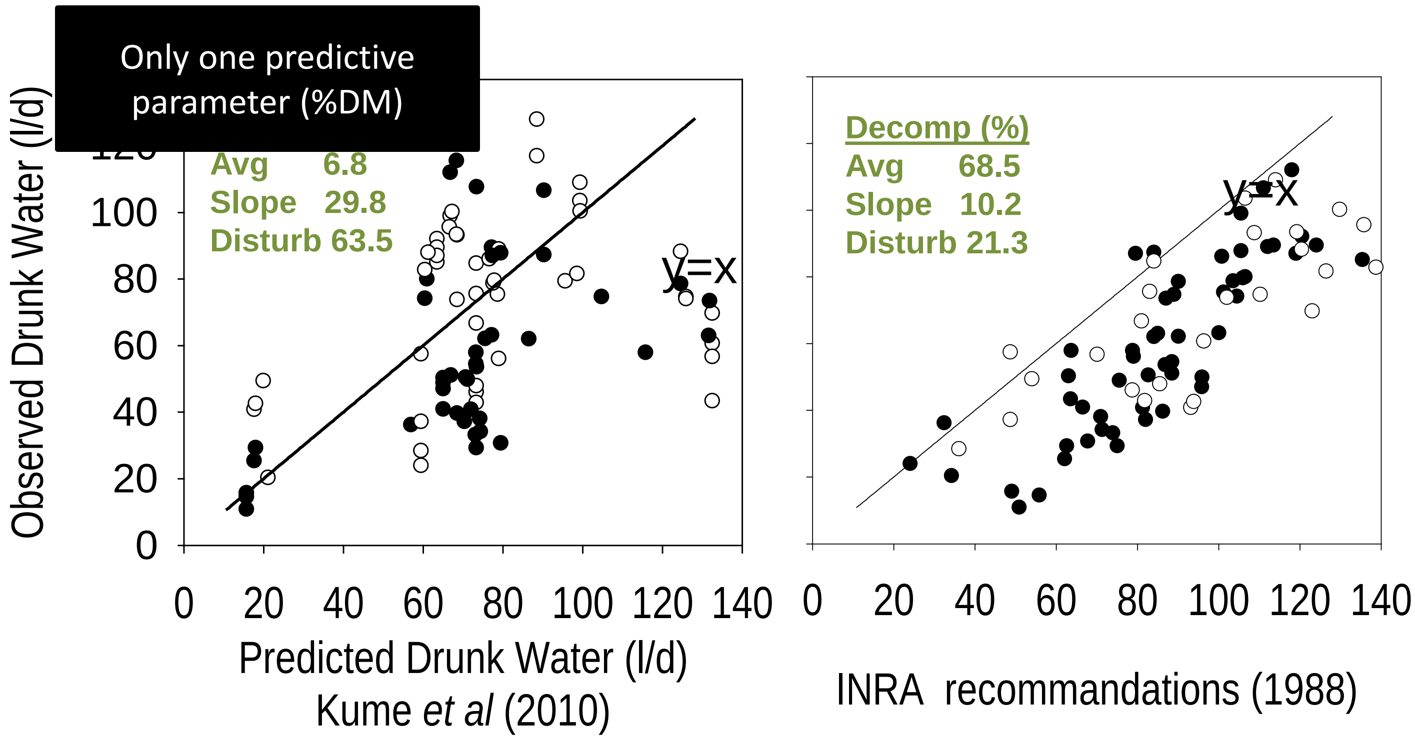
Results



- ● Thermoneutral conditions (d15°C)
- ○ Average daily temperature >15°C

Predictive equations with a relative RMSPE higher than 45%

Resul



- ● Thermoneutral conditions (d15°C)
- ○ Average daily temperature >15°C

Conclusions

- Best relative prediction error of the amount of drunk water that we could obtained with available equation around 15%.
- Diet DM content and average daily temperature were the most important predictive parameters (cf. good predictive performance of the equation of Stockdale and King and the clear underprediction of the amount of drunk water in the 6 equations that did not include the ambient temperature as a predictive parameter)
- Difficulty to assess Na intake in our databasis → Important effect on the predictive performance of the 2 equations including this parameter but … Na intake is difficult to estimate in practical conditions.
- Finally , the lower relative RMSPE were not particularly observed on the equations established with the larger amount of data - Important factors to consider = the conditions in which the equations were established and the possibility to estimate the required predictive variables.

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Thank-you for your attention !

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