

Calculating Greenhouse Gas Emissions from Fires in WA



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Seiler and Crutzen, 1980



Generic inventory algorithm

$$Emission = Activity \times Emission\ Factor$$

For Biomass Burning- a variant of

$$Emission = (Area \times P) \times (BEF \times CC \times EF)$$

Works at any spatial scale, with a few caveats:

- Parameters are spatial means
- Terms are independent


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Current Status of State methodologies

- Savanna (4E)

- - revised and implemented in the NGGI in 2011
- - NGGI and CFI savanna woodland methodology are consistent

- Landuse, Landuse Change and Forestry (5D)

- Prescribed burning of forests
- Wildfires

- Developed in 1994 and parameters assembled/revised by KT
- Last revision ~ 1999

IPCC tier 1 - unstratified.

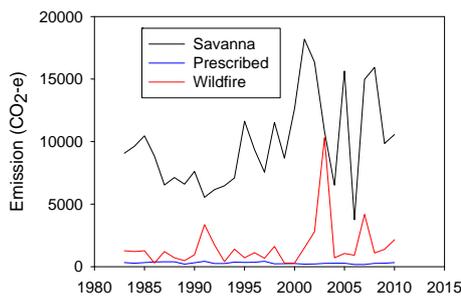
That was a major advance in 1994, but data sources and parameter values have progressed a lot since then



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National Emissions (2006 methodology)

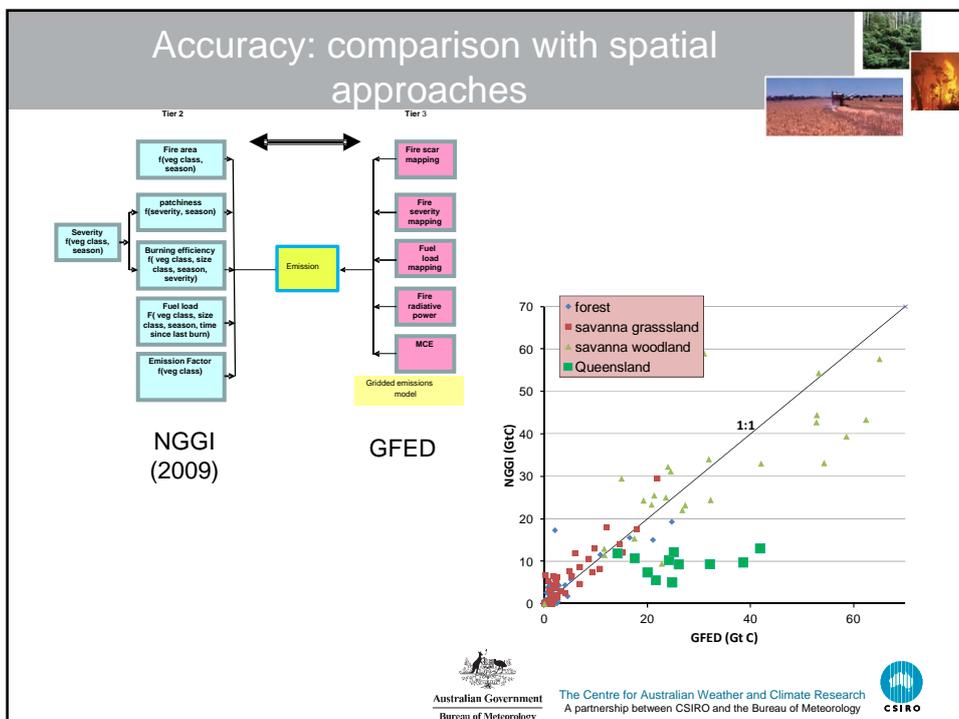
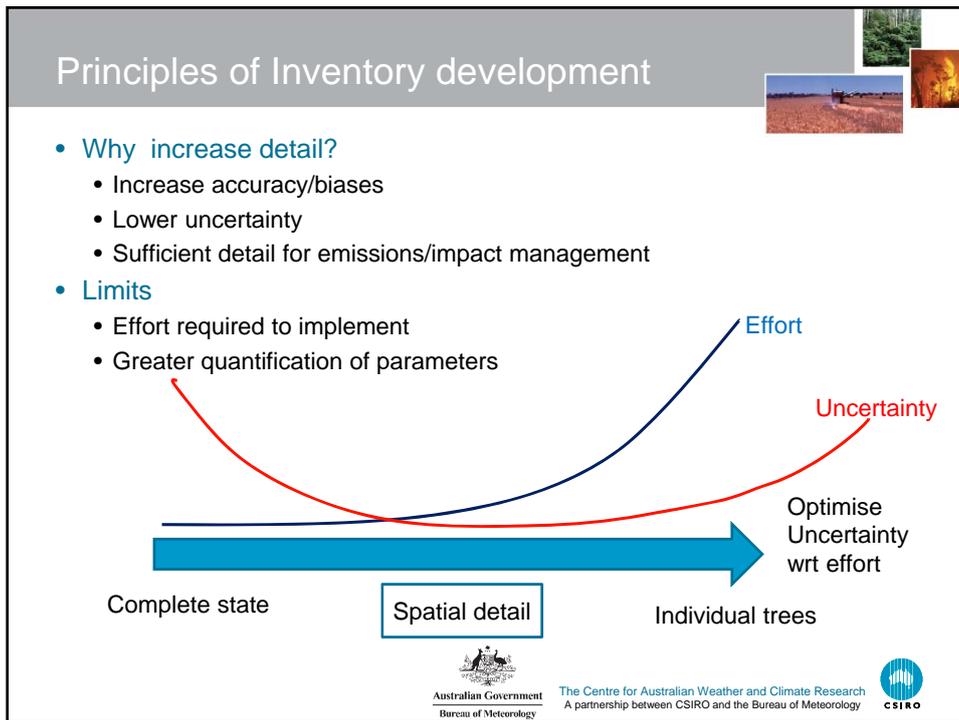


	Gg	% Wildfire
Total CO ₂ -e	293,905	10.4%
Non CO ₂ -e	11,736	13.7%



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- **Theres a lot more data around than there was in 1994**
 - Fire Area: remote sensed and ground-based spatial data
 - Fuel loads and dynamics
 - Emission factors

Particularly for DEC WA
publishes fire area disaggregated by region, fire class
Long history of forest fuel dynamics

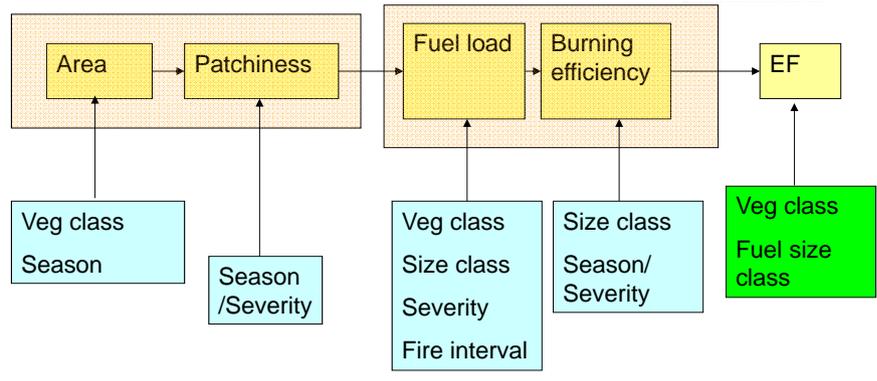
There is also an imperative for mitigation of emissions

- **Revised the Savanna methodology for NGGI and CFI**
- **Have a look at the options for WA forest**





Savanna methodology: level of stratification



```

    graph TD
      subgraph Area_Patchiness [ ]
        Area[Area] --> Patchiness[Patchiness]
      end
      subgraph Fuel_Efficiency [ ]
        Fuel[Fuel load] --> Efficiency[Burning efficiency]
      end
      Area_Patchiness --> Fuel_Efficiency
      Fuel_Efficiency --> EF[EF]
      
      VP[Veg class  
Season] --> Area
      SP[Season  
/Severity] --> Patchiness
      VCS[Veg class  
Size class  
Severity  
Fire interval] --> Fuel
      SCS[Size class  
Season/  
Severity] --> Efficiency
      VFC[Veg class  
Fuel size  
class] --> EF
  
```

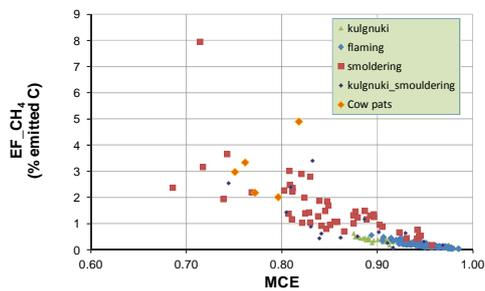
$$E_{oc} = M_o \sum_{pk} \left(A_{pk} P_k \sum_l \left(EF_{pl} FL_{npl} CC_l \sum_m (S_m BEF_{klm}) \right) \right)$$



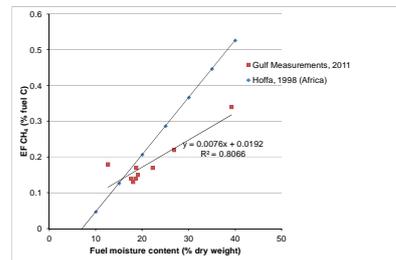
Emission factors- current state in Oz



CH₄ emission factors



Dependence on moisture

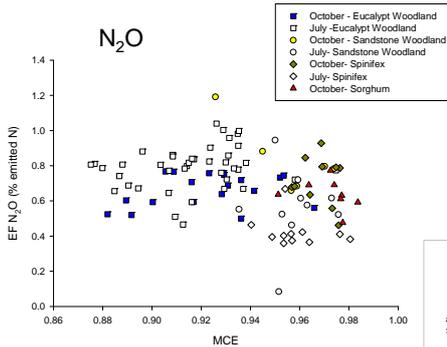


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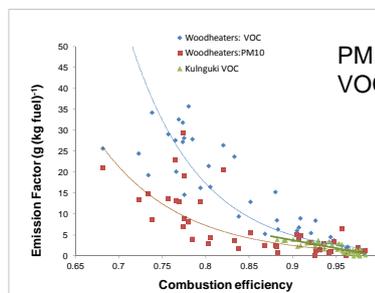
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N₂O



PM, VOCs



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We already have:

- Fire areas by region
- Fuels by size class and age

1st approach is to:

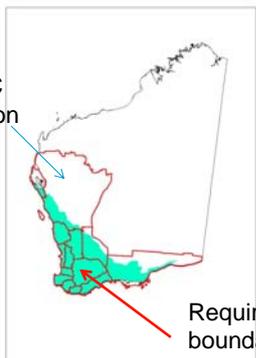
- use the high resolution data to develop area weighted parameters
- apply to disaggregated data currently being reported

 Start to align WA forest and savanna methods
Fix some UNFCCC inventory audit issues

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Regions & double accounting

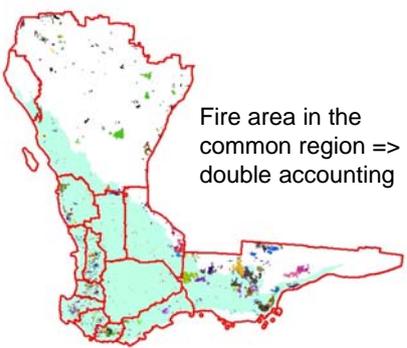




DEC region

Required NNGI boundary

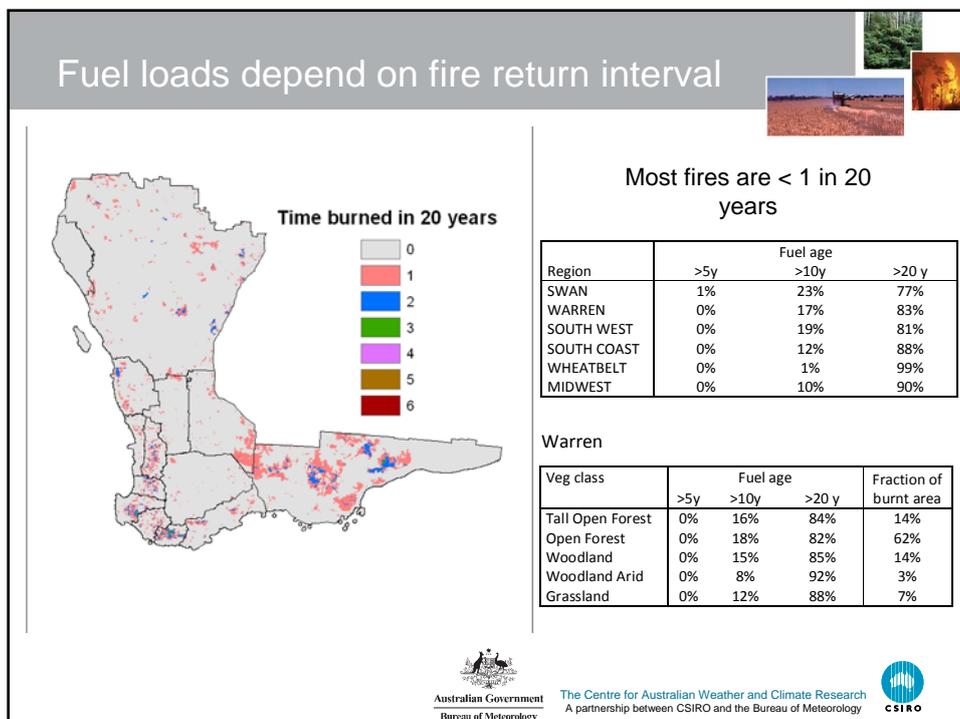
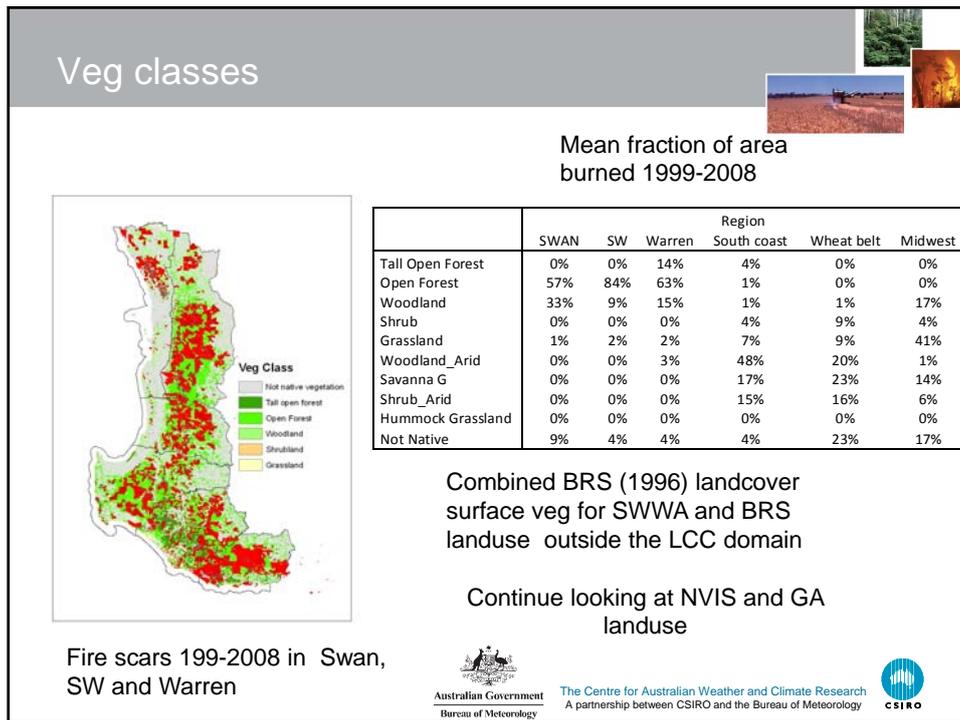
Problem 1- overlap of Forest and Savanna regions



Fire area in the common region => double accounting

Landgate, AVHRR fire scars 1999-2008

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Burnable Fuel

1994 to current NGGI

	Fuel Load (t/ha)	BEF	Burnable fuel (t/ha)
Wildfire	33.4	0.72	24.0
Prescribed	12	0.42	5.0

Suggest revisions from DEC data and recent publications (e.g. Jen Hollis, Lachie etc)

	Fuel load (t/ha)				
	Surface	Shrub	Bark	Logs	Total
Tall Open Forest	32.8	4.0	3.2	71.0	111.0
Open Forest	10.7	2.0	1.8	11.0	25.5
Woodland	8.3	2.6	0.8	17.9	29.6
Shrub	5.7	9.6	0.3	0.5	16.2
Arid Woodland	4.2	2.6	0.3	5.4	12.5
Arid Shrub	5.5	4.3	0.3	0.6	10.7
Total	11.0	3.3	1.4	15.0	30.7

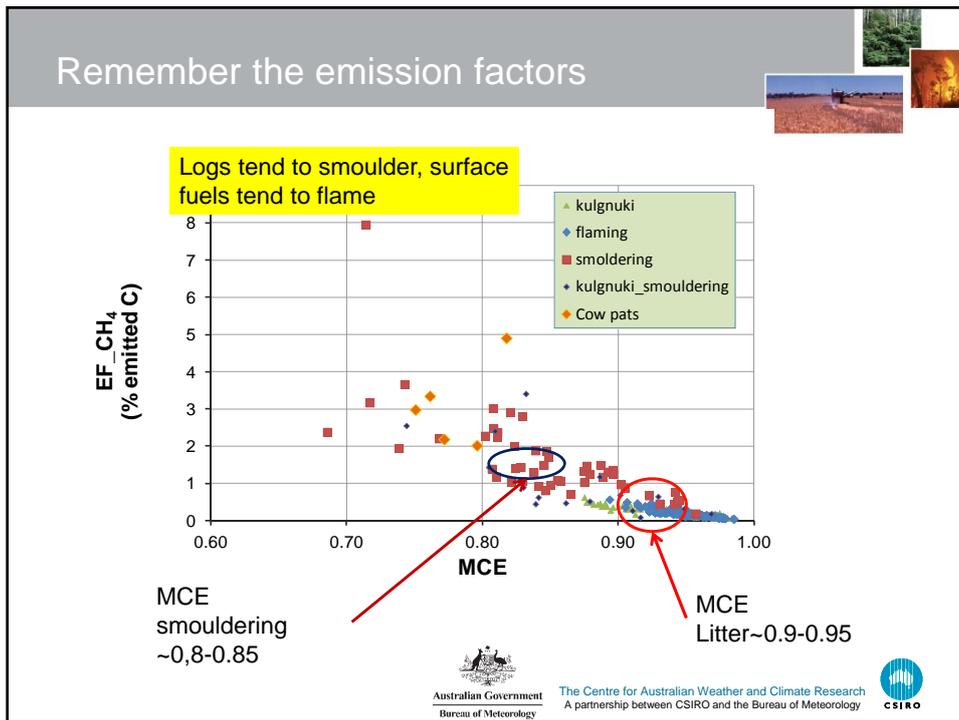
Burnable Fuel

By Region

	Fuel load (t/ha)				
	Surface	Shrub	Bark	Logs	Total
SWAN	10.7	3.2	1.6	15.6	31.1
SOUTH WEST	11.3	3.3	1.7	17.2	33.5
WARREN	11.3	3.3	1.7	17.2	33.4
SOUTH COAST	11.0	3.3	1.2	13.8	29.3
WHEATBELT	11.2	3.3	1.2	13.7	29.5
MIDWEST	10.5	3.3	1.1	12.6	27.5
Total	11.0	3.3	1.4	15.0	30.7

By Season

Class	Burnable Fuel (t/ha)		
	Autumn	Spring	Wildfire
Tall Open Forest	107.7	71.0	134.3
Open Forest	24.4	18.3	30.0
Woodland	28.3	20.7	36.0
Shrub	15.4	13.1	18.5
Arid Woodland	11.9	9.3	14.6
Arid Shrub	10.3	8.8	12.1



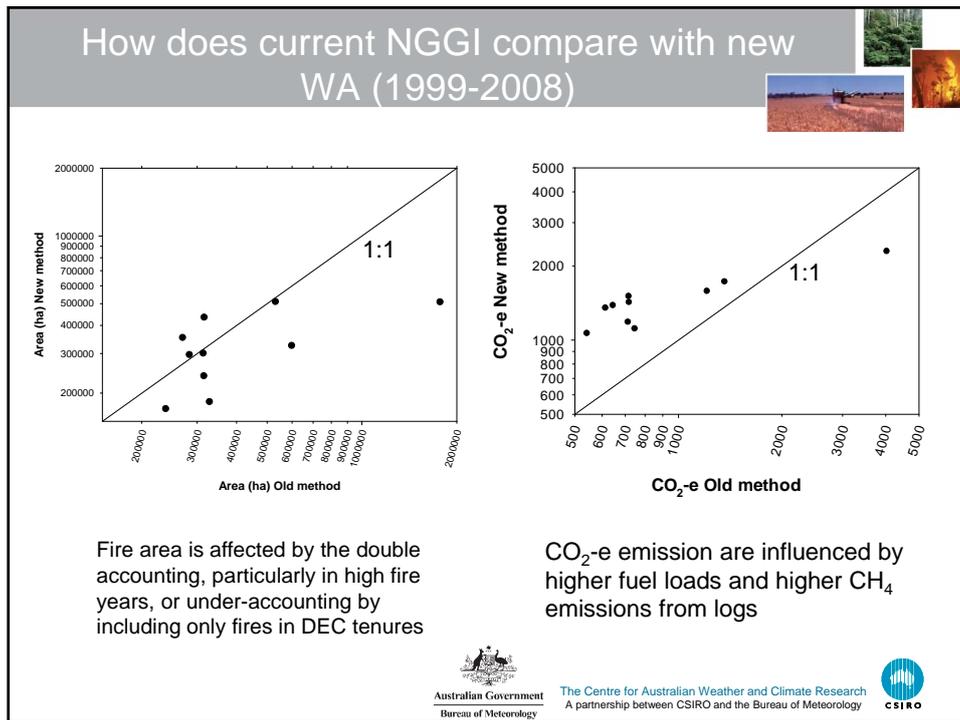
Average CO₂-e emissions

GHG emissions are now dominated by CH₄ from logs

Region	Average GHG emission (Gg CO ₂ -e)				Total
	Surface	Shrub	Bark	Logs	
SWAN	32	5	9	344	391
SOUTH WEST	29	4	8	300	341
WARREN	43	6	11	457	517
SOUTH COAST	26	10	2	134	172
WHEATBELT	5	2	0	9	17
MIDWEST	6	2	0	19	27
Total	142	30	30	1,263	1,465

High wood EF skews the emissions strongly towards the heavy fuels

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- ### Where to from here
- Use Landgate scars in Midwest, Southcoast and Warren
 - An extension of the 2011 NGGI/CFI methodology for savanna
 - Use the 1999-2008 data to refine burnable fuel loads, seasonality
 - Use the fuel size class stratification to weight GHG emission factors
- Conclusions:**
- the overlap of the DEC regions into the NGGI Savanna has affected fire area estimates
 - Appears we have been grossly underestimating burnable fuel loads by neglecting logs and heavy debris
 - Need to confirm fuel loads
 - Address EFs from logs and shrubs.
 - Confirm impact of fire severity on burning efficiency and patchiness
 - Independently estimate emissions
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Thank you
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